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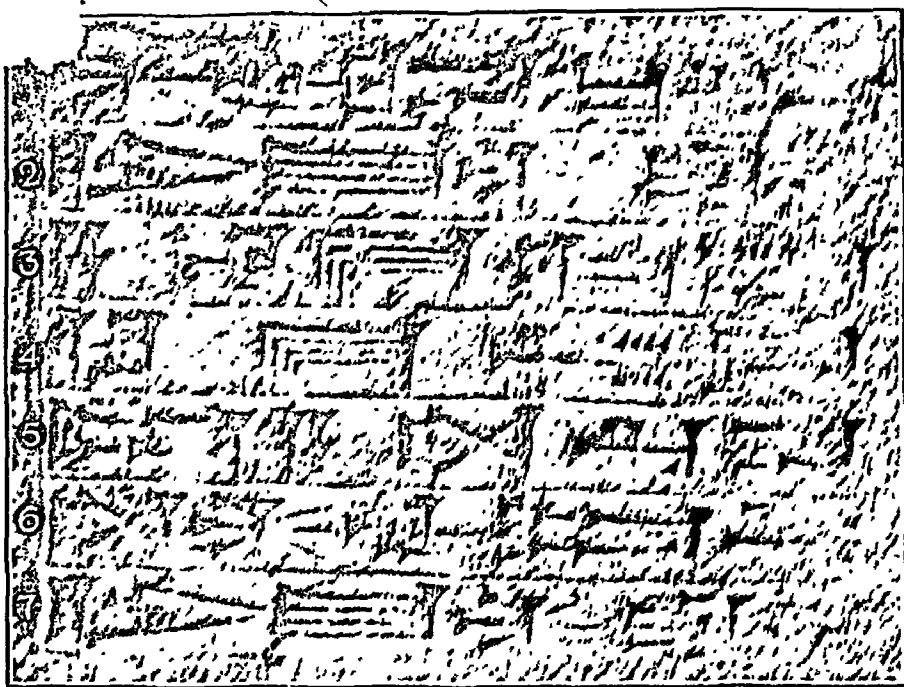
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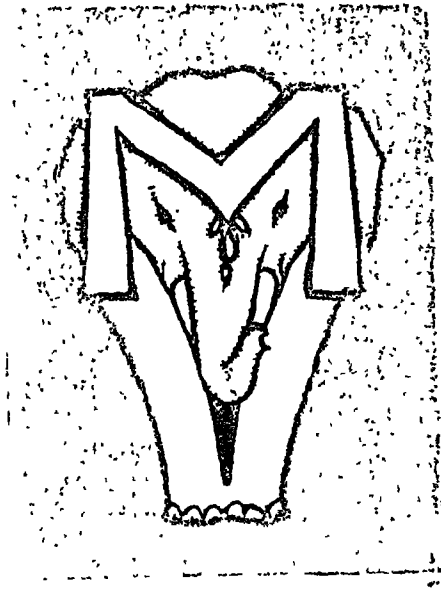
*Inscription relating to the building of a Temple
by King Nebuchadnezzar in the City of Babylon.
He ruled from 604 to 561 B.C. The cuneiform
characters read from left to right and from the
top left hand corner*



TRANSLATED STATE.

- | | |
|------------------------------------|--|
| 1. Nebuchadnezzar. | 4. And the (Temple of) Ezida. |
| 2. King of Babylon. | 5. Anew for lengthening the days (of my life). |
| 3. The Patron of Esaglia. | 6. For God (? Nuba). |
| 7. The Lord a Temple have I built. | |

THE
HIGHWAYS AND BYWAYS
of
INDIA



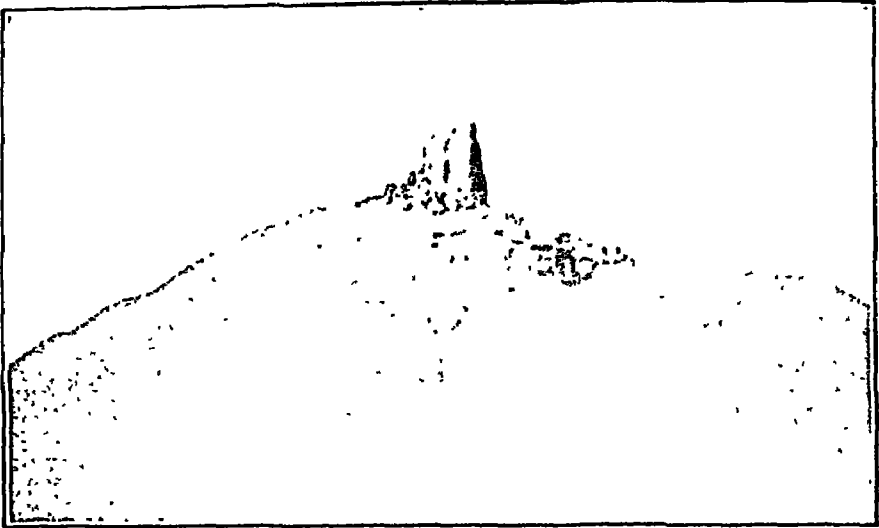
THE MAWSON-VERNON COMPANY, LIMITED
VULCAN HOUSE, NICOL ROAD,
BALLARD ESTATE,
BOMBAY

1929

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The Tower of Babel as it appears to-day.



A detailed View of the Ruins of the Tower of Babel.

PROLOGUE.

*"Nebuchadnezzar, King of Babylon,
he who made Esagla and Ezida glorious,
son of Nabopolassar, King of Babylon.*

*The streets of Babylon,
the Procession Street of Nabu and Marduk,
My Lords,
which Nabopolassar, King of Babylon, the father who begot me,
has made a road glistening with asphalt and burnt brick.*

*I, the wise suppliant who fears Their Lordships,
placed above the bitumen and burnt bricks,
a mighty superstructure of shining dust,
made them strong within with bitumen and burnt bricks
as a highlying road.*

*Nabu and Marduk, when you traverse these streets in joy,
may benefits for me rest upon your lips,
life for distant days, and wellbeing for the body.*

*Before you I will advance upon them.
May I attain eternal age !"*

It will at once be agreed that there is something particularly noble in the sound of this language, which is the translation of an inscription in Cuneiform characters, impressed upon a road-paving brick from the streets of Babylon.

Over 2,500 years have rolled by since that was written, and, even with the present-day craving for widespread knowledge at the hands of Publicity Associations, it is thought that no warrant of Patronage exists over a longer period than this for any thing the world produces and which is now being utilized in ever-increasing quantities.

Let us, therefore, Gentles, Up with the curtain ! and display for your enjoyment and, perhaps, enlightenment, scenes which portray the Being and Doings of Bitumen.

A WORLD-OLD MATERIAL.

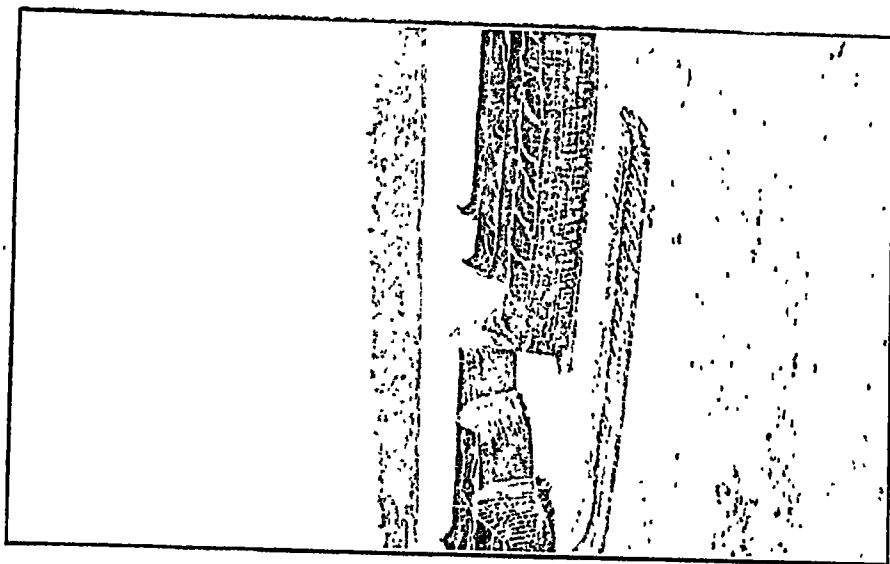
The earliest record of the use of Bitumen relates to the Sumerians, a people inhabiting the Euphrates Valley prior to the ascendancy of the Babylonians, and some of the oldest relics which have been recently unearthed, demonstrate that asphalt was used by them as a cementing medium or binder for attaching small objects or ornaments to sculptures, carvings and pottery.

Asphalt was also mixed with clay to form a dense mastic which could be moulded or carved into various forms. Such a mastic cast in the form of an heraldic device excavated at Lagash near the mouth of the Euphrates, dates back to 2850 B.C. As early as 2500 B.C., the Egyptians utilized liquid or melted asphalt as a preservative coating for the cloth wrappings of mummies.

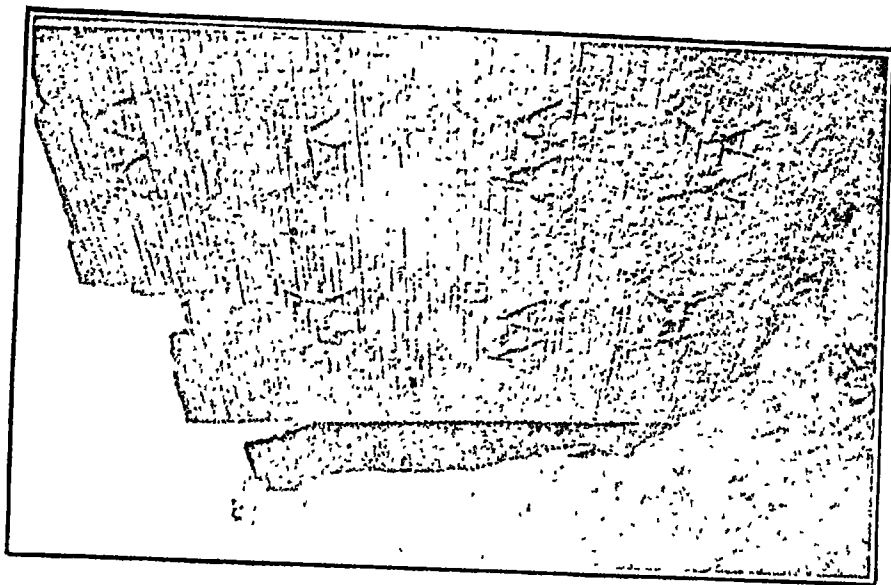
As a mortar for brick, asphalt was evidently used in the construction of the Tower of Babel, for the Book of Genesis states that "slime had they for mortar" and the word "slime" is translated as "bitumen" or asphalt in the Vulgate. This same "slime" is also recorded as having been used to daub the basket of bulrushes which served to conceal Moses when the children of Israel were suffering under the bondage of Egypt about 1500 B.C.

Nearly a thousand years elapsed before the use of asphalt in highway construction apparently suggested itself. It was Nabopolassar, King of Babylon, who first used asphalt as a filler or mortar for brick pavements. His son, Nebuchadnezzar, continued this practice as is proved by the inscription found on bricks taken from one of the streets.

Nebuchadnezzar also used asphalt extensively as a mortar in the construction of brick walls and foundations which were subjected to water action, and similar use was made of asphalt in the ancient city of Media. Thus, long before the Flood (about 3000 B.C.), apparently; the value of asphalt for binding, moulding, preserving and waterproofing was recognized and utilized in and about the Mediterranean region which has been termed the cradle of humanity.



*Boat hulls with skins of rushes coated with
Bitumen to keep them watertight.
(? Moses' Basket Model.)*



*Babylon : A lasting monument to those
builders whose ancient knowledge is
a fit subject for perpetual homage.*

In the Western Hemisphere, asphalt was also known and used in ancient times by the Incas of Peru, who established a magnificent system of highways paved with a substance not unlike "bituminous macadam"—undoubtedly asphalt. Certainly natural deposits of asphalt were known by the most primitive peoples, for such existed in many parts of the world and antedated the earliest known races of humanity. This is attested by the remains of prehistoric animals which some of them contain.

One of the most interesting of all deposits of asphalt occurs at Los Angeles, California, just off Wilshire Boulevard and about eight miles from the centre of the city. From this deposit the University of California has excavated entire skeletons of a great variety of prehistoric animals. These animals, venturing upon the surface of the asphalt when it was soft, stuck fast, just as insects stick to fly papers. Gradually they sank below the surface, later to furnish excellent proof of both the cementing strength and preservative value of asphalt. The skeleton of an elephant, fifteen feet high, has been taken from this deposit and bones of such animals as the mastodon, sabre-toothed tiger, giant sloth, camel, horse, bison, lion and wolf. Numerous species of birds have also been recovered from it.

A number of theories have been advanced by noted scientists on the origin of asphalt as it occurs in nature, but all of these theories establish the fact that, in its production, petroleum plays the part of parent. In fact, the natural transformation of petroleum into asphalt is to-day taking place in plain view in certain localities. Petroleum which is capable of producing asphalt, is known as asphaltic petroleum and actually contains a substantial amount of asphalt dissolved in light oils, just as glue may be dissolved in water. Seepages of such petroleum through the earth's crust to its surface, and accumulations of these seepages in natural depressions have produced asphalt deposits, through the gradual evaporation of the lighter solvent oils. A few years ago an oil company operating in Mexico had an over-production of petroleum from some of its large wells. To save the material, about twenty-one million gallons were impounded in a nearby valley and three years later, through natural evaporation, this petroleum lake had been transformed into a mass of soft asphalt.

With the growth of the petroleum industry and the increased demand for asphalt, petroleum refiners quickly learned how to recover asphalt from asphaltic petroleum. The first commercial asphalt thus produced was recovered from Californian petroleum and was known as "petroleum asphalt" to distinguish it from asphalts produced in nature. After a comparatively short period of experimental refining, it was found that high grade asphalt could be successfully recovered from certain petroleums and that the purity and consistency of such asphalts could be scientifically confined within very narrow limits.

Having, as it were, formally introduced you to the subject, Bitumen, let us proceed without further delay, to unfold before you that part of the history which relates to those fields which are both nearer home and better known to us, owing to the preservation of the Written Record of the World and Creation around the Garden of Eden.

The Highways and Byways of India.

CHAPTER I.

A LITERARY THUMB-NAIL SKETCH OF ALMOST THE EARLIEST NATURAL PRODUCT KNOWN TO MANKIND SINCE THE CREATION.

NATURAL BITUMEN.

THE use of bitumen as a water-proofing and binding material, goes back to respectable antiquity.

We are informed that Noah's Ark was "pitched within and without"—a very necessary precaution in view of the prolonged voyage of that world-famous vessel. There is good reason for believing that the seaworthiness thus imparted to the good-ship 'Ark' prevented its untimely foundering and despite the great advance in ship-building which has taken place since Genesis, bitumen, as a caulking material and anti-fouling composition for the bottom of sea-going vessels still maintains its unequalled time-honoured reputation.

Besides its historical connection with ship-building, bitumen was also used in the ancient civilisations of Mesopotamia as a cement, which fact is witnessed in the ruins of Nineveh in Assyria and in Ur in Babylonia, in which latter city so many remarkable discoveries have recently been made. Not the least noteworthy among the results of recent archæological investigation in ancient Babylonia is the discovery that the old-time builders were well aware of the exceptional and valuable properties possessed alone by bitumen as a permanent binding material, for the massive brick structures still to be seen on the sites of the ancient cities of Mesopotamia, and notably in the *Zigurats* of the city of Ur, have stood the test of time and are the admiration of every architect who has been privileged to see them.

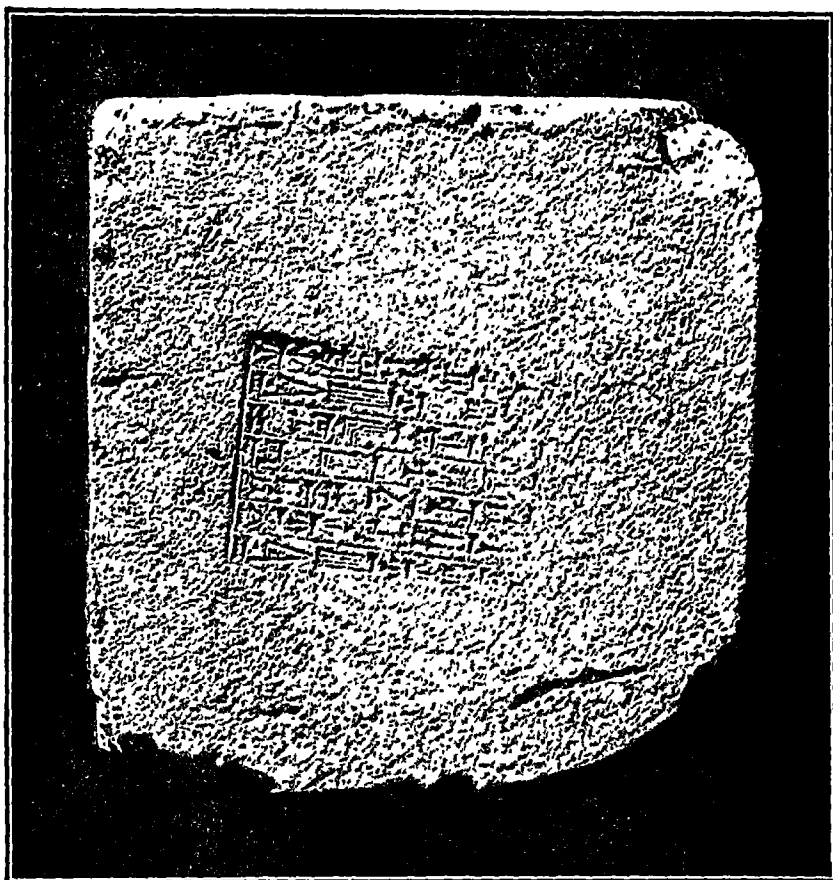
This is hardly surprising when it is considered that one of the most remarkable bituminous areas in the world is situated in Iraq and that an ideal substance for the preparation of a

durable, impervious cement exists on the spot and proclaims to this day the sound judgment of the ancient builders who selected it. In view of this early knowledge possessed by ancient mankind, it is, at first sight, somewhat extraordinary that the superlative virtue of bitumen for binding purposes was lost to view until the 19th century, when the employment of bituminous compound, commonly known as Asphalt, originated for the paving of European cities. Many centuries elapsed since the time of Nebuchadnezzar, during which the properties of this invaluable natural substance were ignored and the world's original field of supply was lost to view, as it were.

The first Asphalt which appeared as a commercial product and which is still widely used, is that procured from the Lake of Trinidad, and when speaking of Asphalt, or Asphaltum as it should more correctly be called, it is generally this particular substance which is brought to mind.

It may well have been, however, that the seemingly insuperable difficulties which surround the whole enterprise of obtaining supplies of the world's original bitumen from the Iraq fields, were more than sufficient to damp the ardour and wear down to a point of desperation, the tenacity and endurance of even the most hardy prospective pioneers. Time, however, has, as it were, a faculty for producing here and there, at intervals of a few hundred years, an individual or small group of men who refuse to be deterred by conditions of difficulty and hardship which have reasonably proved more than adequate to give their predecessors cause to cry, ' enough.'

Such a group has been steadily whittling down the barriers and obstructions during the past five years ; gradually sapping away the natural fortifications which held this bituminous treasure fast and safe, as it were, behind almost impenetrable entrenchments, until, at last, sustaining conditions of almost unprecedented endurance, India to-day is in possession of her first Refinery and Works, composed and erected with material from India, by Indian labour, and adequate supplies of as fine a Natural Bitumen as the world produces are already in India, transported from the same locality and almost identical in composition with that used by Nebuchadnezzar's builders.



*View of Face of Babylonian Brick.
Impressed inscription in Cuneiform characters.*



Back View of Babylonian Brick with Bitumen still embedded, after 2,500 years.



Bituminous Babylonian Brick showing Imprint of Reed Matting.

CHAPTER II.

IRAQ BITUMEN—THE BINDER !

A FEW words are now permissible regarding the conditions in which natural Iraq Bitumen as imported by the Mawson-Vernon Company, is found in Mesopotamia and collected chiefly from surface deposits, where there is a supply adequate to meet the heaviest anticipated demand for many years to come.

We are dealing, therefore, not with a substance for which future demand might exceed the supply, but with a natural product upon which we can draw upon as heavily as we like for many years to come.

This surface bitumen is particularly rich in its bitumen content and compares favourably with others in the very front rank of the natural asphalt of the world. It contains in its natural state, on an average, about 80 per cent. of pure bitumen, that is to say, of those essential binding and water-proofing constituents of all asphalt.

Iraq bitumen, when first found in small lumps of lustreless appearance, is perfectly dry to the touch, although, in its natural state, it is exposed to terrific sun temperatures in summer and to temperatures much below zero in winter, and, unlike all other natural and residual asphalt, it remains perfectly stable and never flows. It is, no doubt, due to the fact that Iraq bitumen has been exposed to these extremes of temperature for thousands of years, and has thereby acquired its peculiar qualities. It is sun and air cured; volatiles which exist in other bituminous compounds were either non-existent or else have been refined out of it and, by means of exposure to the forces of these natural processes over immense periods of time, the substance which now is available and exists for our use, is more perfect than could be manufactured by the most up-to-date methods of production in any refinery.

In this connection it may be mentioned that samples of asphalt used as cement between Babylonian paving and building bricks have shown, on analysis, less than 1 per cent. of variation in its construction than is disclosed by analysis of the recently imported raw material brought to the works.

The bitumen freshly removed from its bed in the depth of the brick, was found to emit a distinct asphaltic odour when a flame was applied to it, and that after some 2,500 years. Truly Natural Iraq Bitumen unheated by artificial means, is indestructible.

The surface bitumen is collected by hand, packed in gunny bags and transported by camel or specially provided motor transport across unmarked wastes of storm-swept sandy desert, to the river bank from whence it is shipped in local craft some 500 miles to the Persian Gulf, and re-shipped for preparation in the Mawson-Vernon Refinery and Works at Wadala, Bombay.

Whilst in transit in ships' holds, this raw bitumen, in pieces roughly about the size of large apples, is exposed to exceedingly high temperatures, yet it never coagulates, or becomes viscous or in any way changes its condition from that which it presents when lying on the open Mesopotamian plains.

Its stability is one of its most salient and, at the same time, one of its most valuable properties, and this feature which it possesses in unequalled degree, entirely differentiates, elevates and distinguishes it above all other bitumen compounds whatsoever.

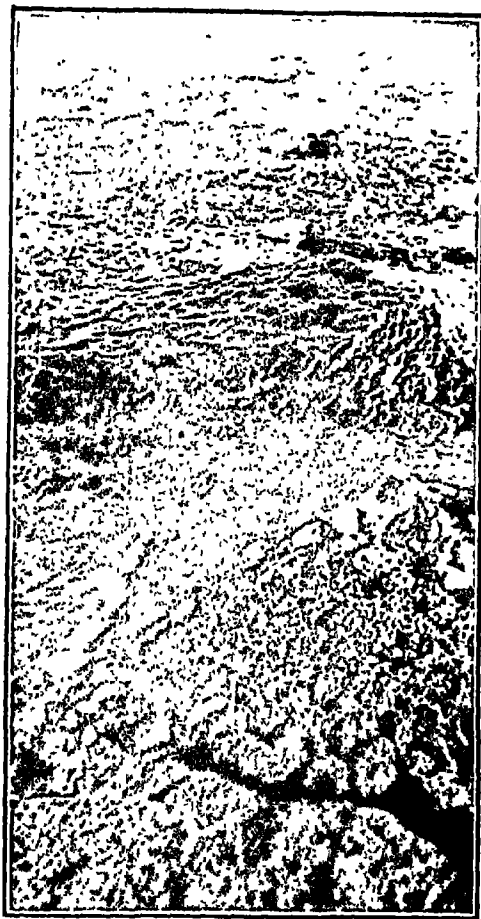
Every consignment of bitumen, on reaching the Mawson-Vernon Refinery and Works, is analysed, after which it is treated in a variety of ways according to the purpose for which it is destined.

Owing to its naturally friable and brittle condition, Iraq bitumen can be easily pulverised, which is rarely, if ever, the case with other bitumens of equal degree of purity, and which mostly have to undergo pyrogenous treatment before they can be rendered sufficiently brittle to enable them to be pulverised.

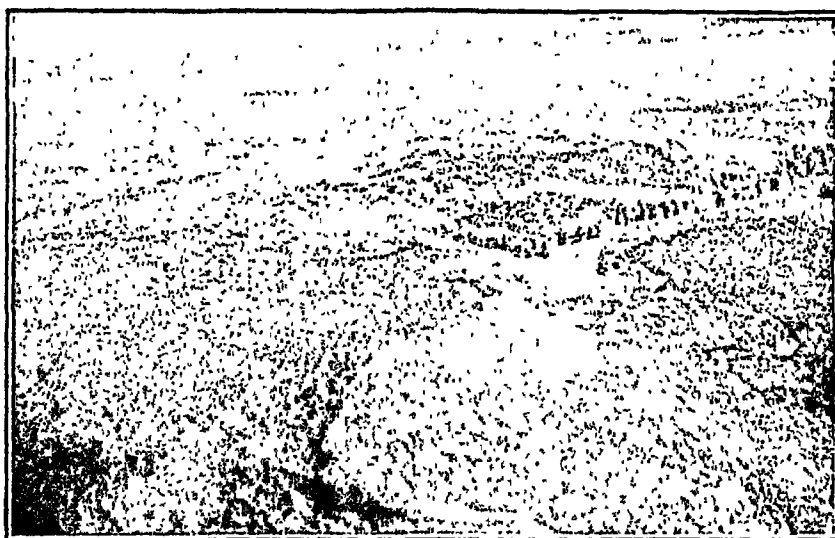
It is obvious that pyrogenous treatment is not only expensive, but, in very many cases, deleterious to the bitumen itself, as it has to take place at temperatures of about 400°-600°F. for prolonged periods, with the result that the complex structure of the bitumen undergoes changes which impair its essential qualities. With Iraq bitumen, however, which has a Flash point above 600° F. there is absolutely no risk of the bitumen being charred or otherwise impaired as is so often the danger with other asphalt.



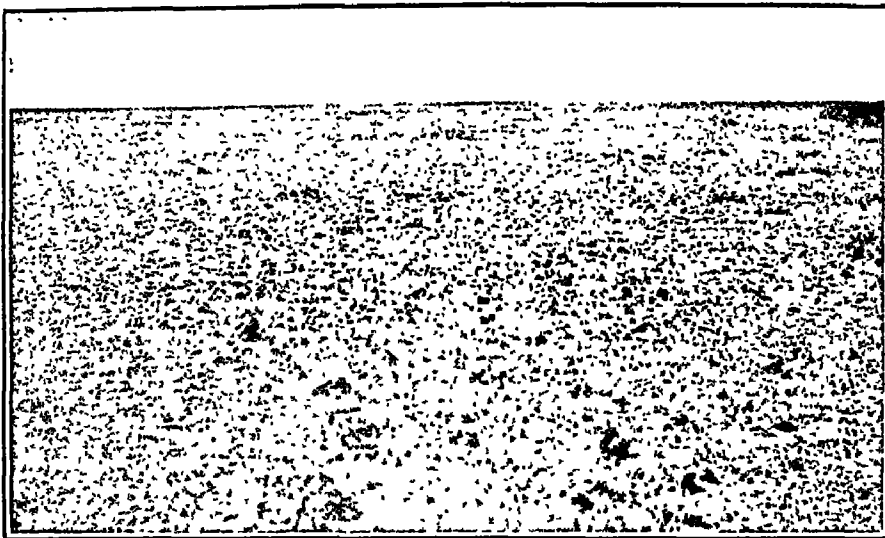
Crust 1 in the Process of making and baking.



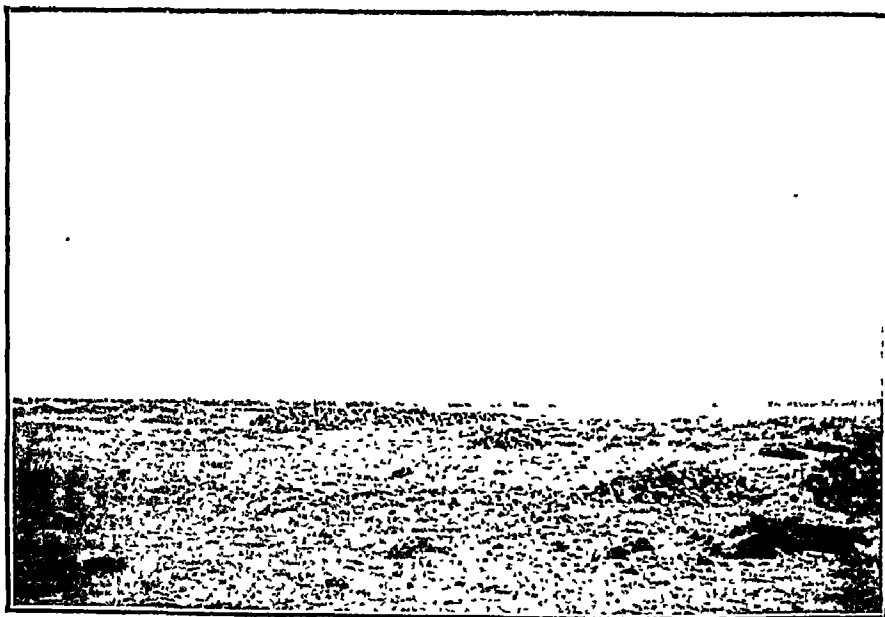
View of a second source showing the Birth of Iraq Bitumen—The Binder.



A typical source of supply which ultimately will become pulverisable Natural Iraq Bitumen.



*The Desert.
Iraq Bitumen has forced his way through the Pores of the Earth, as it were,
and formed solid "Flowers."*



Iraq Bitumen in natural surroundings.

Iraq bitumen being easily pulverisable in its raw state, can be reduced to any degree of pulverisation desired, and in this condition can be combined with any ordinary road-making material such as sand, gravel, slag, granulated granite, stone, etc., and thus constitutes the ideal road-making compound. Every road engineer knows that this is impossible when working with hot asphalt which cannot be *intimately combined* to form one homogeneous mass with other materials, but must be *applied*.

Iraq bitumen, besides being pulverised for combination with road metals, is refined and converted into asphaltic cement in the Mawson-Vernon Refinery and Works, by the addition of flux oil for the manufacture of road blocks, tiles and expansion boards, the last named being for insertion between concrete slabs to prevent the unavoidable cracking and speedy dissolution which overtakes concrete road surfaces when laid solid. These expansion boards also form "shock-absorbers," as it were, which nullify to a large degree, the damage attributable to vibration influences which are sustained in cases of tramway tracks and the like.

Whatever other virtues Iraq bitumen may possess, there is one which will certainly not lack appreciation by road engineers, and that is its ability to combine with any available material which it is desired to use for road metal. There is no necessity to stipulate any particular metalling material with Iraq bitumen. The Mawson-Vernon Refinery and Works will supply powdered bitumen to combine with your own grades of road materials. No matter how inferior or intractable they may be, the right combination will be forthcoming which, when laid, will provide a perfect road.

It is a complaint common among road engineers, that they keep on pouring metal into a road without proportionately improving it. This being the case, a great deal of road-making really resolves itself, eventually, into mere road repairing. Many a road which should have become better and better with the passage of time and treatment, has actually deteriorated and has to be patched constantly in order to keep it in even tolerable repair.

An entirely different state of affairs takes place as soon as road-building begins with Iraq bitumen. The bitumen

combines with the material and being perfectly stable, insoluble and chemically inert, in short, indestructible, remains in the road. It cannot be washed away; the sun cannot cause it to flow; frost cannot injure it; water in no way affects it, with the result that its binding properties remain and increase with compression and the lapse of time. After a few years of gradual application of comparatively thin layers of road metal combined with Iraq bitumen, a compacted road is acquired which, to all intents and purposes, is permanent and cannot be injured either by the heaviest traffic or the severest weather conditions. It is possible, therefore, for road-making to be projected with the use of Iraq bitumen as an investment. If funds are low, a light dressing of combined material can be applied to consolidate itself. At a later date, this can be thickened.

Every article of material so put in the road, remains in it, and, in course of time becomes a durable, waterproof, dense mass.

This enables any Public Body to commence a system of road construction which will be a remunerative investment owing to the fact that eventually a stage will be reached when repair work will be the exception rather than the rule.

The use of Iraq bitumen may therefore justly be described as the most efficient and most economical method available, whether it be regarded from the standpoint of initial expense or viewed as an eventual reduction of expenditure.

To provide a hot asphalt plant is expensive, for which reason alone many Public Bodies are definitely precluded from making use of anything of the kind. It is, however, within the power of practically any road authority in the Peninsula, to provide the small, easily portable and very inexpensive plant which is all that is required for the making of road surfaces with the Mawson-Vernon pulverised bitumen and local road material. The question of capital expenditure upon plant, scarcely enters into the field of consideration with the use of cold Iraq pulverised bitumen, as the comparison it shows with the outlay necessary for the plants generally used for hot asphalt, tells preponderantly in its favour.



*Iraq Bitumen clearly seen in the form of
solid mushrooms.*



*Just a 'Crust'
of
Iraq Bitumen—The Binder!*



An 'Old-World' Natural Garden of Asphalt Flowers.

The Mawson-Vernon Refinery and Works at Wadala represent the largest plant of its kind, not in Asia alone, but probably also in Europe, for the commercialisation of cold pulverised bitumen.

It is anticipated that the demand in India and in the East generally, will, in a short time, expand considerably as it is clear that a substance which can withstand the extreme variations in climatic conditions which a road surface has to endure in the East and the simplicity and inexpensiveness of application, is one which must instantly spring to the front.

At the present time the Mawson-Vernon Refinery and Works are able to produce, daily, about 100 tons of pulverised natural asphalt, a quantity sufficient to provide some 15,000 square yards of 2-inch consolidated carpet. Expansion in production is simple to achieve, the moment the demand justifies that end, for each unit of the plant is complete and can be added to whenever desired.

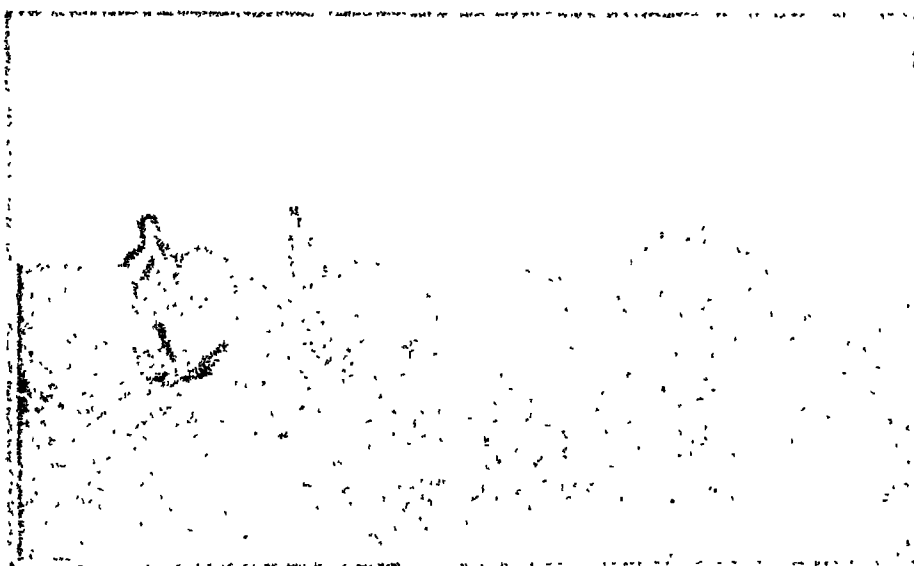
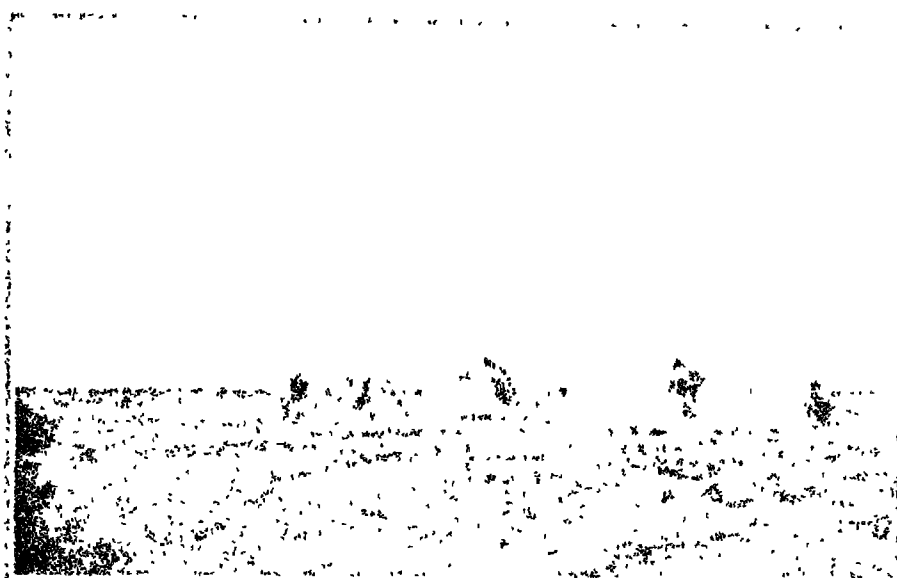
Taken as a whole, the Mawson-Vernon plant is unique in so far that it has been built up by engineers who have devoted years to the design of an ideal plant to handle the raw material. This has resulted in the creation of a Refinery and Works which could not be purchased as they now stand. Each unit is the fruit of specialised experience and individual design, embodying the conclusions of years of special research, coupled with first-hand information as to the recent and most modern developments of both hot and cold asphalt road work as at present existing in the United Kingdom, Europe and elsewhere.

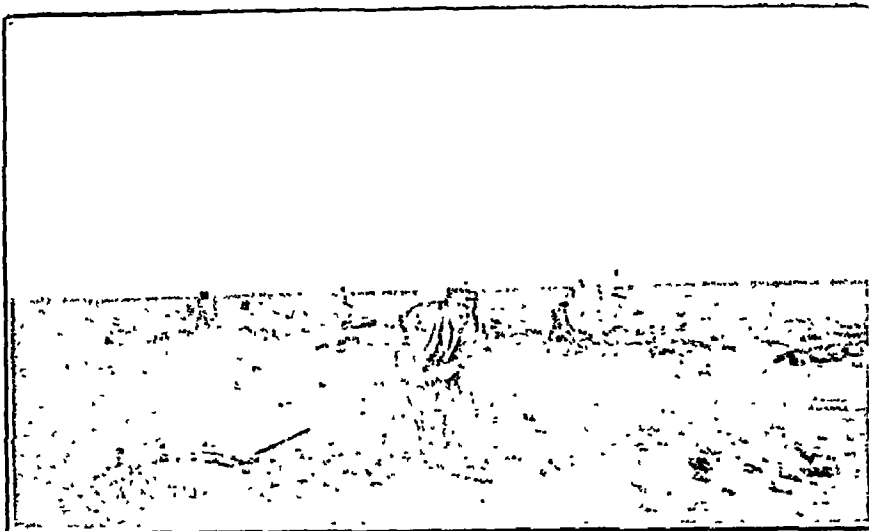
The laboratory, certainly, is unequalled in India and probably is the finest in the commercial road world. It is replete with apparatus of the most modern design to enable the raw material and manufactured products to be subjected to the most exhaustive tests. No parcel of material will leave the works until it is guaranteed to fulfil all requirements, whatever they may be.

Investigation is constantly being carried out for the purpose of discovering new properties and, if possible, new uses for this invaluable natural product, which, it is hoped, will prove the means, in the future, of providing India with a

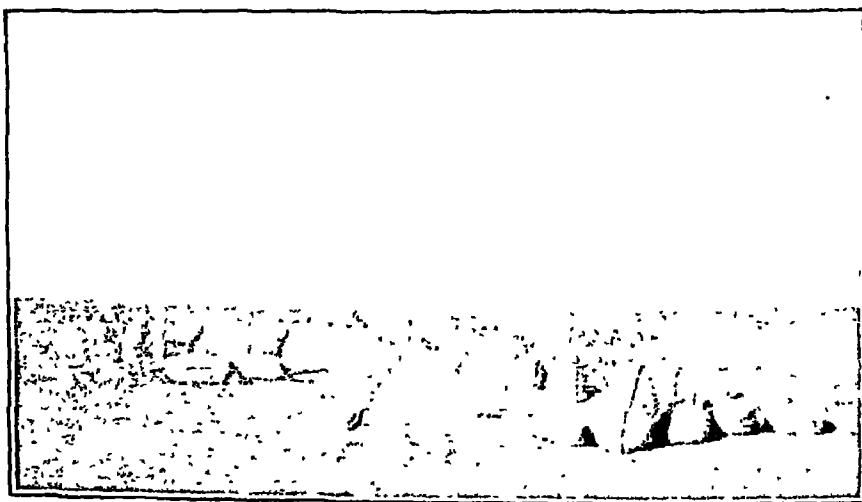
system of roads, at a reasonable cost, which will bear comparison with those of any country under the sun, and which will be a most valuable possession of India's peoples.

It is only possible, of course, for the Company to be thoroughly *au courant* with the most modern methods of construction and research in matters appertaining to roadway engineering,—embracing as it does, subjects relating to the proved and most suitable aggregates and the delicate adjustments to fillers, liquifyers and fluxes,—by the provision of a technical staff of chemists and engineers. The outcome of their previous experience in the United Kingdom and elsewhere, during the past ten years, has given them the opportunity to study the difficulties, problems and remedies in all branches of surfacing and treatment, during a decade of unparalleled construction, development and experiment. In Great Britain, at least, unique fields for the acquisition of road knowledge have existed under the auspices and guidance of Sir Henry Maybury, K.C.B., K.C.M.G., G.B.E., the late Director General of Roads, who, as a result of post-war expansion of mechanically-propelled road vehicles, was burdened with a task unprecedented in magnitude and crowned with a degree of success hitherto unattained in the experience and progress of the national routes of any country in the world.





Gathering 'Flowers' in the Asphalt Garden of Iraq Bitumen.



*Gathered Asphalt Flowers in heaps and packed in Gummy Bags.
(The latter in great demand to replenish the wardrobes of the local gentry.)*

CHAPTER III.

THE NEW ERA.

COLD ASPHALT AND IRAQ BITUMEN.

It can, without question, be said that the prosperity of a country depends very largely, commercially, upon the provision of means of inter-communication. In fact, transport, in any country, is the life blood of its industrial health and prosperity. If, therefore, its highways are the arteries and veins through which that life blood courses, they must be adequate to maintain unrestricted circulation.

In a country embracing vast areas, such as India, it is imperative and essential that roadways, adequate to the general needs, should be provided and maintained at a cost which is economical both in the direction of initial outlay and annual upkeep, by the provision of surfaces which will withstand high sun temperatures and the abnormal scour of the monsoon, and, at the same time, reduce to a minimum the ever present nuisance of dust.

There is only one material known to mankind which is available to achieve this objective, and that is natural bitumen. This product is now available, for the first time in history, in India, in a form which will enable road surfaces in any part of the country to be provided without the provision of expensive and ponderous machinery, involving the consumption of large quantities of fuel and water, and this by means of a process which eliminates the application of heat throughout.

This factor of heat, which always has been and always will be a source of danger, is frustrated.

Heating bitumen to the recognized temperatures may easily and unavoidably involve its partial or total destruction, with the consequent loss of funds, time and labour, apart from the failures which ensue therefrom to provide efficient road surfaces, whereby the peculiar and varied types of transport, from the fast motor car to the ever-present bullock cart, are enabled to proceed upon their respective ways, as speedily as their needs demand, without hindrance and without any undue expenditure of public funds.

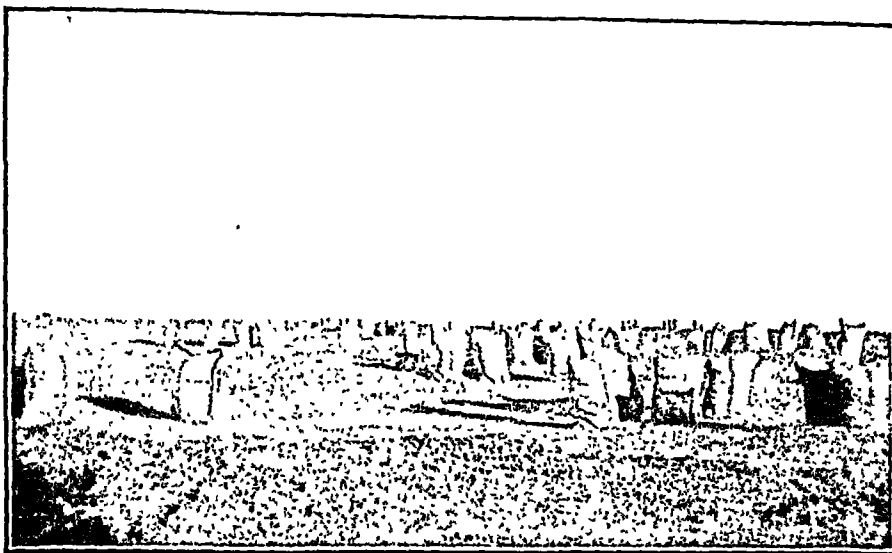
A process which will permit of the formation of such road surfacing to be carried out, is now possible for the first time in any part of the world, through the erection and installation of the Mawson-Vernon Iraq Natural Asphalt Refinery and Works at Wadala, Bombay.

The entire provision of the plant and apparatus has been drawn either from the country, or manufactured and assembled on the site by local artificers and labour. The whole can be maintained and operated entirely without the necessity for extraneous aid. Thus will it now be possible for India to provide in its own Refineries (for further installations in other parts are already contemplated), with the aid of local employees, adequate materials to meet her every need in the road world of to-day, and at prices which will ensure economy both in the initial cost and also in expenditure upon ultimate maintenance.

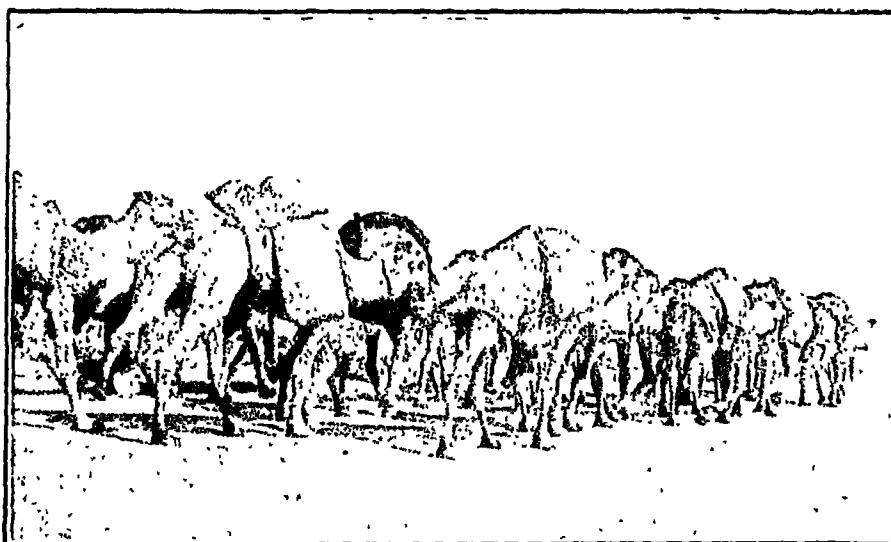
We shall now proceed to explain the means whereby this particular mode of manufacture, without the application of heat, is rendered possible. Immediately prior to dealing with the practical nature of the process, it is obviously desirable to dilate somewhat upon the subject of Asphalt generally and this Company's Asphalt in particular, for, to the majority of those engaged in road works, the mention of Asphalt has invariably brought up a mental picture of fire and heat. In this individual and unique instance, fire and heat can be totally disassociated from this form of Asphalt, for the provision of neither heat nor water obtain.

Natural Asphalt, in an appropriate form, is the oldest and best form of binder known throughout the road world.

The very best of Asphalt, however, is easily and irretrievably ruined by the undue application of heat. This can only be guarded against in India and elsewhere, by acute supervision and the provision of expensive and complicated plant. Even then, immunity from burning cannot be guaranteed, for, however good the agitation, it can never be avoided that the Asphalt nearest the fire-box does not endure greater temperatures than those imposed upon material constantly in movement by means of mechanical agitators installed in the heating kettles.



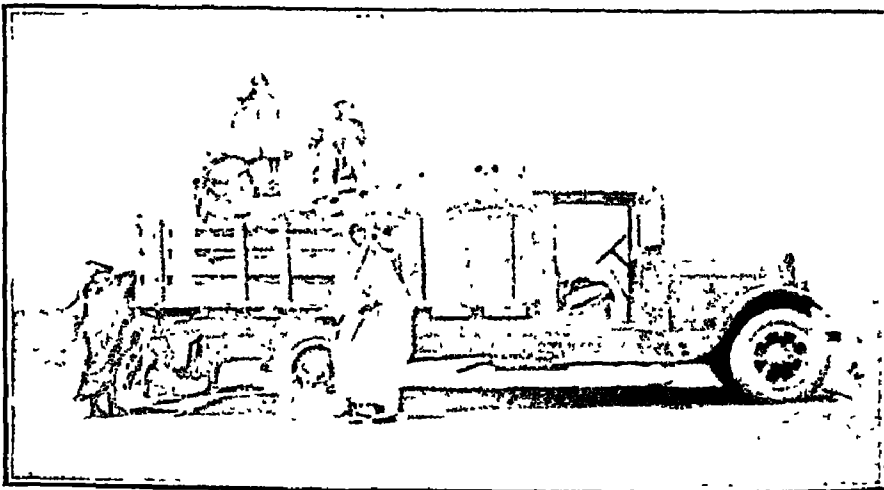
*"Harvest Time."
Awaiting the Camels.*



Camel Caravan off down the long long Trail to River Euphrates.



Asses also assiduously assist on the journey riverwards.



Mechanical means of moving Iraq Bitumen. Note the Armed Desert Guard (Highly Necessary).

At no stage whatsoever in the Mawson-Vernon process of manufacture does the natural asphalt come into contact with temperatures provided by direct flame heat.

The following particulars therefore may be read in a state of mind entirely disabused from any feelings of past fears based upon previous experience of Asphalt of the "Hot-Mix" type. The day of necessity for hot processes is past and that of "Cold-Mix" has dawned.

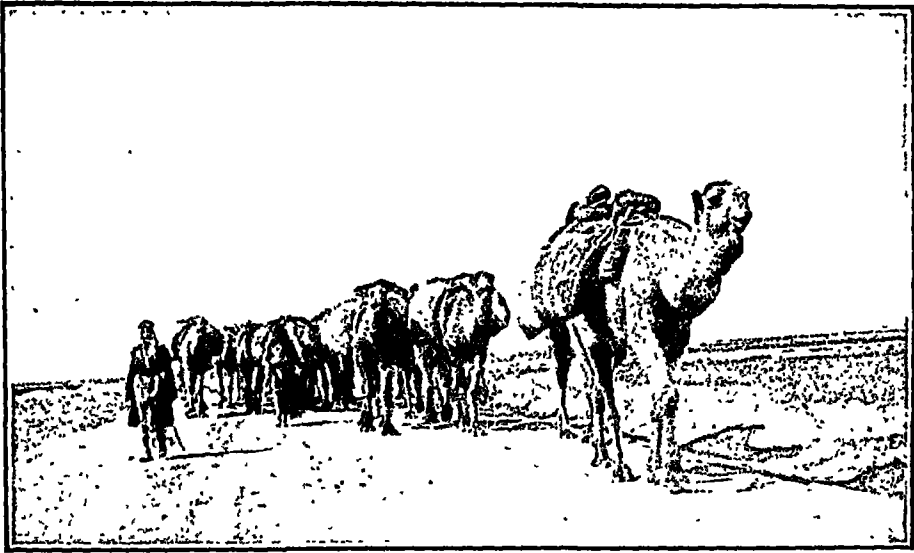
In describing or discussing bitumen or Asphalt, natural or residual, of every kind at present known, it may be taken for granted that it is indubitably the aim and object of every thinking person engaged in road works, to obtain a binder which is as nearly as possible, perfect in its natural form. Thus it may be a matter merely of transplanting it, as it were, from its native source to that in which it is required, without in any way changing its structural, chemical and physical qualities detrimentally.

No such changes arise through the mere fact of transplanting Asphalt from a location where it has been exposed to all the atmospheric variations of thousands of years ; temperatures of over 160° F., which fall below zero ; flood and storm ; sand and wind, all of which conspire to produce, naturally, for man's use in road work, a binder in natural form, unsurpassed anywhere in the world. Transportation to areas where it is needed, is only a means to permit of its use in convenient form, to enable roads to be made or surfaced with material produced by Nature herself under conditions extending over vast periods of time.

Nature's ways and means are beyond the power of artificial imitation even by modern processes, as is exemplified in the formation of the natural diamond, and, as the natural diamond in the world of gems, is to the artificial or imitation diamond, so is the natural asphalt in which this Company specialises, compared with other natural asphalts, for from it alone can "Cold-Mix" Asphalt Roads be constructed.

The qualities of Iraq Natural Asphalt which are the outcome of the ordinary transmutations of Nature herself, working in her own simple, unhurried and inimitable way, are so strikingly apparent that they leave no room for doubt or question as to their natural perfection.

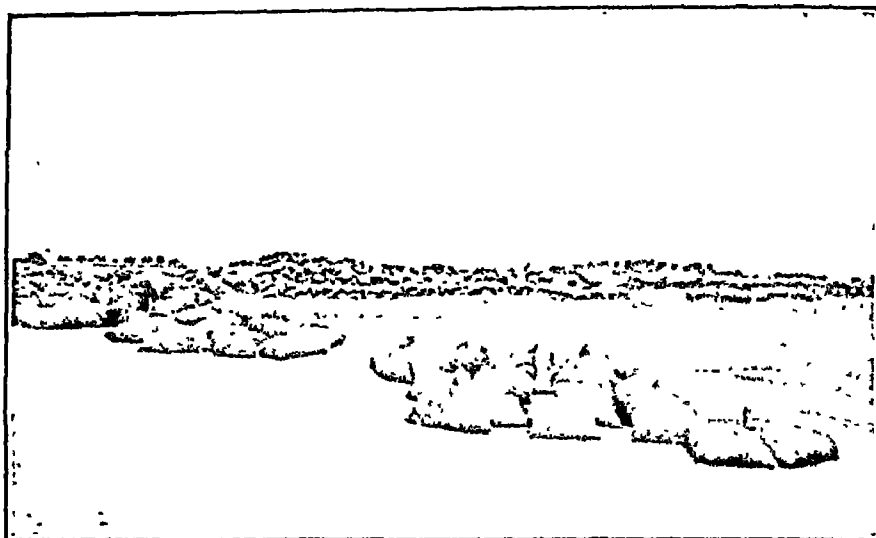
That which will be equally apparent is the entire inability on the part of any institution engaged in the mass production of oleaginous commodities, to manufacture and supply a truly comparable material from sources which, comparatively, but a short while ago, were regarded as unavoidable residues, and which, even at the present date, reasonably enough, form an admirable side-line in the endeavour to meet competition successfully in the world's markets of petrol, fuel oils and lubricants.



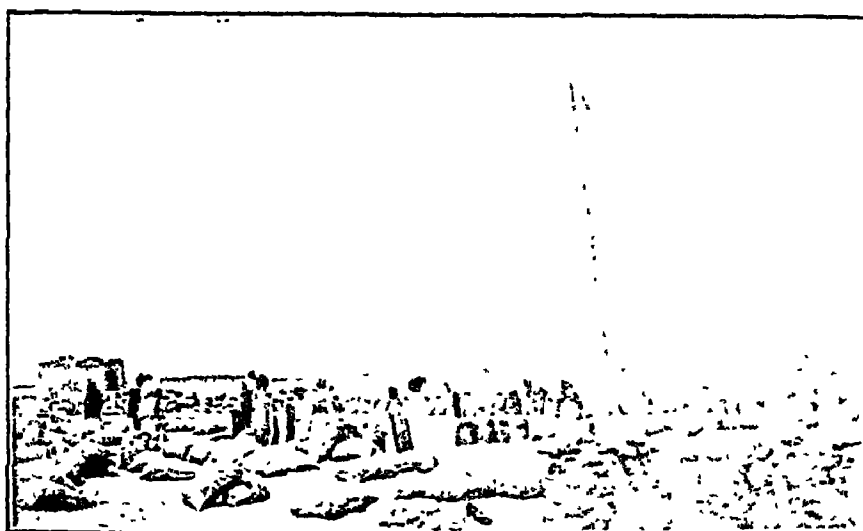
Safe on the High Road to the River.



Supplies of Iraq Bitumen brought by Motor Transport to River Bank.



*Iraq Bitumen—The Binder which never 'weeps'
by the Waters of Babylon, awaiting arrival of Craft.*



*Loading into River Bonts on the Euphrates.
The Circular Erektion to the left is a small Fort. (Verb. Saps.)*

CHAPTER IV.

COLD ASPHALT IN THE MAKING

WITH

IRAQ BITUMEN.

WE can now consider the means whereby roads in any part of the world may be constructed with the aid of such a natural Asphalt as a binder, to meet the ever varying needs of particular areas.

Let it, however, be constantly borne in mind that upon the strength, durability, unvarying constancy and tenacity of the binder, the life and effectiveness of the road surface depends.

Road surfaces with a sufficiently good binder to hold them, have been produced by means of treated ashes, clinker, or almost any such refuse materials, and with no small degree of success. The success is due to the binder entirely, for it holds the material firm against the melting power of the sun, the abrasions and impact of traffic, the scour and permeation of rain, each with its potential consequent damage to the surface, all of which are avoidable, provided the binder is adequate to withstand the several offensives made upon it.

Each and every one of these demands is faithfully met by the "Cold-Mix" Asphalt produced at the Wadala Refinery and Works under the Company's process, or by any Public Body using this identical process and material.

It is essential now, to give a brief description of the process by which this natural bitumen, when culled from the desert wastes of Iraq, is rendered down to that form in which it is supplied for the use of all and sundry, far and wide.

The natural Asphalt is first passed through an ordinary stone breaker which reduces it to an appropriate gauge for its reception and ultimate treatment by the pulverising plant. It is interesting to note that Nature's efforts on behalf of man have so dealt with this Asphalt deposit, that crushing and pulverisation are processes of simplicity, whereas in the case of every other known Asphalt of equal standing, in its original form, such a procedure has been well known to be an unfortunate physical impossibility.

The pulverised Asphalt is now ready either for the immediate manufacture of "Cold-Mix" in the Refinery Grounds or for transportation to Alaska or Peru, for the preparation there of "Cold-Mix" with equal simplicity.

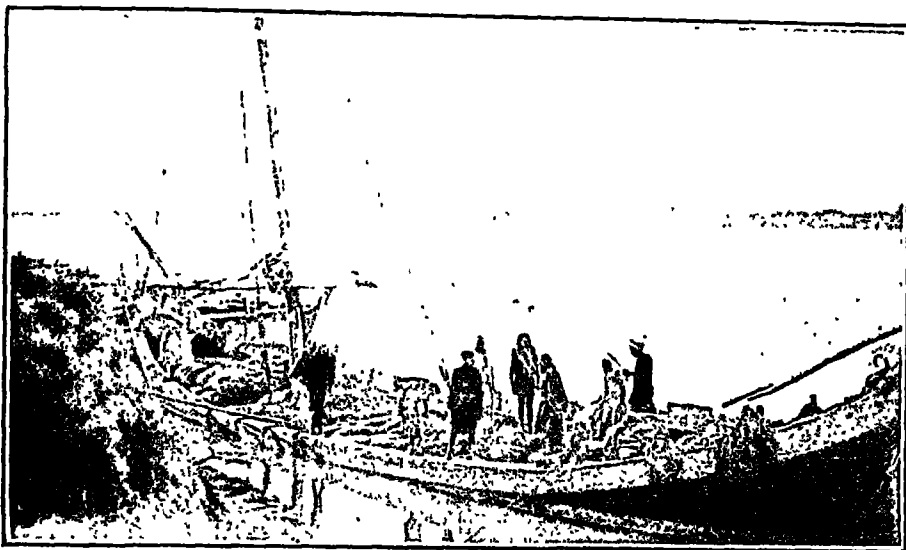
In case such a suggestion of transportation across the face of the Globe should appear ridiculous, it is equitable to emphasise the fact that for every 100 tons of Pulverised Asphalt so transported, roughly, 15,000 square yards of 2" consolidated road surface can be made and laid from local supplies of stone and sand or whatever road making resources are prevalent.

The cost of transport is a negligible factor in comparison with the super-type of road surface attained and that without any heavy expense for plant provision, its maintenance or running costs of production.

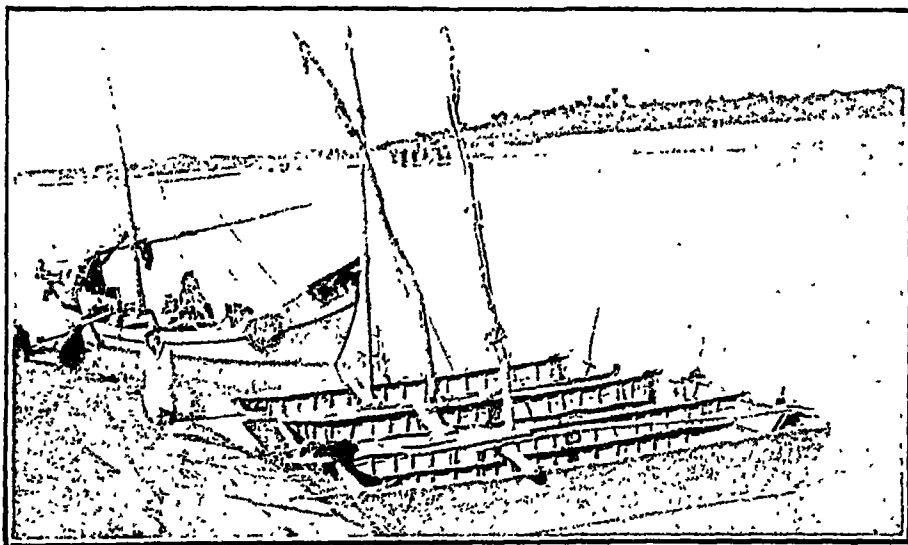
The only machinery necessary comprises two small Pug Mills, of the paddle mixing type, which the Company is engaged in manufacturing in its foundry and workshops. Thus, Public Bodies and others engaged in surfacing with "Cold-Mix," can obtain the requisite plant at cost price, and also eventually, spare parts, without fear of being subjected to delay while waiting for the arrival of such necessities from Europe or the United States of America. The whole of this section is also a further source of employment for local labour.

These Pug Mill Units can be economically driven electrically, or by a small petrol or oil engine, in fact any suitable power type which is prevalent locally, according to the conditions of the district, and, complete with an adequate internal combustion engine, will represent an outlay of approximately Rs. 7,000.

To revert to the manufacture of "Cold-Mix": we have the Iraq Bitumen now ready in pulverised form, and into the first Pug Mill is introduced the appropriate quantity of all the materials of which the road surface, held fast by the Asphalt binder, is to be formed. This Mill, by rotation, causes these materials to be thoroughly mixed and immediately afterwards the necessary quantity of light flux oil is injected and the pulverised natural asphalt introduced. The mixing continues, and upon completion, the contents are conveyed by gravity



Iraq Bitumen—The Binder ! Goes aboard.



*Boats on the Euphrates.
(Water-tight propensities by Iraq Bitumen.)*



" Weighing-in."
More Modern methods now prevail.



The Mawson-Vernon Offices, Baghdad.
The Thousand and one days and nights here relate entirely to the present tale
of Iraq Bitumen—The Binder !
(The original assessment of Forty Thieves has already been appropriately
adjusted.)

into the second Pug Mill where the whole is finally coated with a prescribed heavy flux oil.

“Cold-Mix” is now ready for transport to the road or for transit to works within an economical distance from the Refinery and there it may be laid instantly or stored for weeks, it is only a question of adjustment.

It is within the pale of reasonable probability that the simplicity of this process of manufacture, will astound those associated with modern methods of Asphalt road surface construction and, in particular, those conversant even with “Cold Asphalt” as that term is understood by Road Engineers in Canada, Great Britain and Europe to-day. There is nothing undesirable in that and nothing extraordinary, for, without a grain of doubt, the discovery and process of manufacture at India’s very first Asphalt Refinery and Works, will astound not only India, but the road making Confraternity throughout the world.

The need for practical experience, by keeping in closest touch with the methods, prescriptions, advantages and shortcomings of those processes in Europe, the United Kingdom and America, which are deemed to be in the front rank of world wide efficiency at the present moment, has for some years, past, been to the fore in the minds of the Company’s Governing Directors, Laboratory Staff and Engineers who are fully conversant with the appropriate details of those leading modern processes.

The advent of the Mawson-Vernon “Cold-Mix;” however, will result in a different order of precedence. India will lead ! India has the only Refinery and Works in the world and the only source of supply which enables pulverised asphalt to be supplied as an economical commercial undertaking.

To get back to the road, however, it only remains for the “Cold-Mix” to be spread and rolled and the traffic immediately turned on to it. Nothing further remains to be done.

Traffic conditions prevailing in each particular area, of course, will involve due consideration being given to each individual project, but it is only a matter of hours before a

recommendation is given as to the best method of dealing with a specified undertaking.

"Cold-Mix" can be laid in the form of a single coat surface; or a base coat and top coat, a total in the aggregate of 4" of material consolidated by rolling to 3", or $3\frac{1}{2}$ " consolidated to $2\frac{3}{4}$ ", or 3" to $2\frac{1}{4}$ " or even a 1" or $\frac{3}{4}$ " wearing coat.

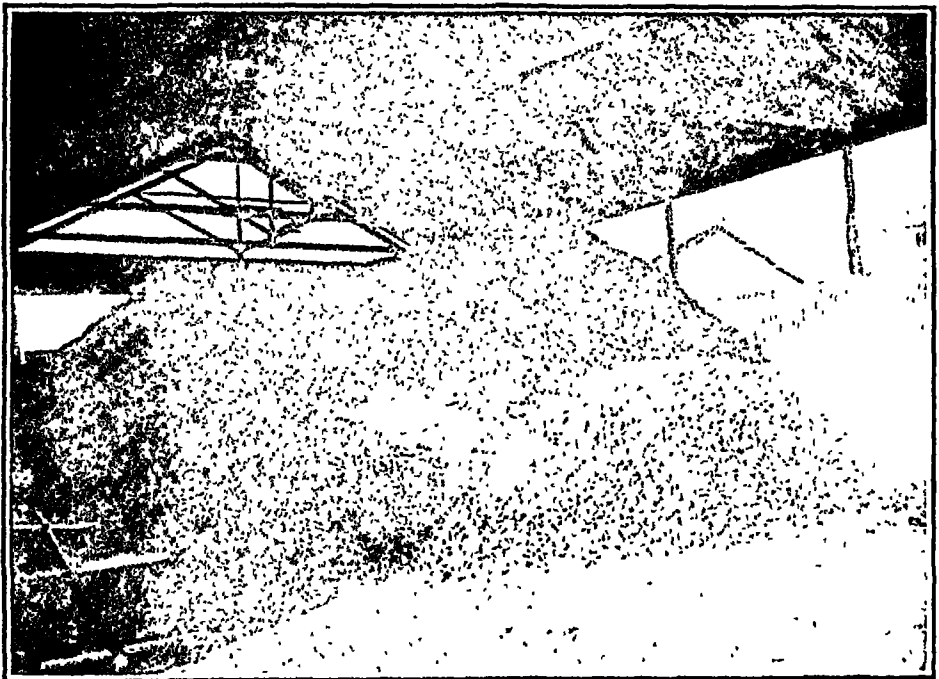
The ultimate compression and impinging blows imposed by passing traffic, only serve to complete the final change created by the action of the roller in the initial stage, for it is this compression which sets up a process of liberating a temporary superfluity of volatiles introduced in the mixing process, which results in an almost voidless mass, bound together as no other road surface can possibly be bound and which the constant force of impact will but serve to improve, never to destroy.

Nothing further need be said with regard to the "Cold-Mix" process, and indeed what is there which requires to be said when such a discovery and such a road surface is already being prepared in Bombay itself?





Bitumen in Gunny Bags from Iraq arriving at the Refinery (Wadala).



Supplies of Natural Asphalt as received from Iraq.

CHAPTER V.

HOT ASPHALT

AND

COLD IRAQ BITUMEN.

THE period has now arrived when it is necessary to turn from factors which are of sufficient interest to give cause for a sense of enthusiasm, to dry facts dealing with those essential particulars of analysis whereby the Mawson-Vernon Asphalt may be judged and in consequence, set apart as a Peer in its own right among the Asphalt of the world.

Natural Unrefined Iraq Asphalt.

Bitumen Soluble in CS ₂	..	..	80 Per cent.
Insoluble in CS ₂	{	Organic	.. 4 „
		Inorganic	.. 16 „
Insoluble matter consists of Calcium Carbonate and Silica.			
Flash Point	..	..	Over 600° F.
Fusing Point	..	..	Over 280° F.
Volatiles	..	..	Nil.
Water	..	..	„
Penetration (77-100-5)	..	..	1-2.
Asphaltenes	..	..	27 per cent.
Colour	..	..	Lustrous.
Fracture	..	..	Conchoidal.
Adhesiveness	..	..	{ Over average native bitumen.

This Asphalt is higher in purity than most Native Asphalts. Its high Flash Point ensures stability, and the percentage of Asphaltenes gives extraordinary backbone.

To meet the particular requirements of paving and street work in different climates, special grades of Asphaltic cement can be prepared by us, advancing in penetration from :—

5	..	..	10
10	..	..	20
20	..	..	30
30	..	..	40
40	..	..	50
50	..	..	70
70	..	..	100

The actual blending of the carefully selected Flux Oils with our Pulverised Asphalt is carried out in steam heated and steam agitated kettles. No open fires are used and every alternative has been taken to eliminate completely the risks of high temperature resulting from direct firing.

The greatest advance in the direction of improvements in Asphalt road construction within recent years is the discovery that Asphalt can be introduced into a road mixture in a cold state and actually mixed with an aggregate at atmospheric temperature without the application of artificial heat either to the stone or binder.

The "Cold" method is exactly the reverse of that which has now been in existence some 40 years and by which it was essential to raise the Asphalt and aggregate to a temperature of about 350° F. and then mix them. We will allude to this older method as the "Hot-Mix."

It is necessary to mention some of the more serious disadvantages of a "Hot-Mix" and at the same time deal with these disadvantages as they are overcome by the "Cold-Mix" process.

Hot.

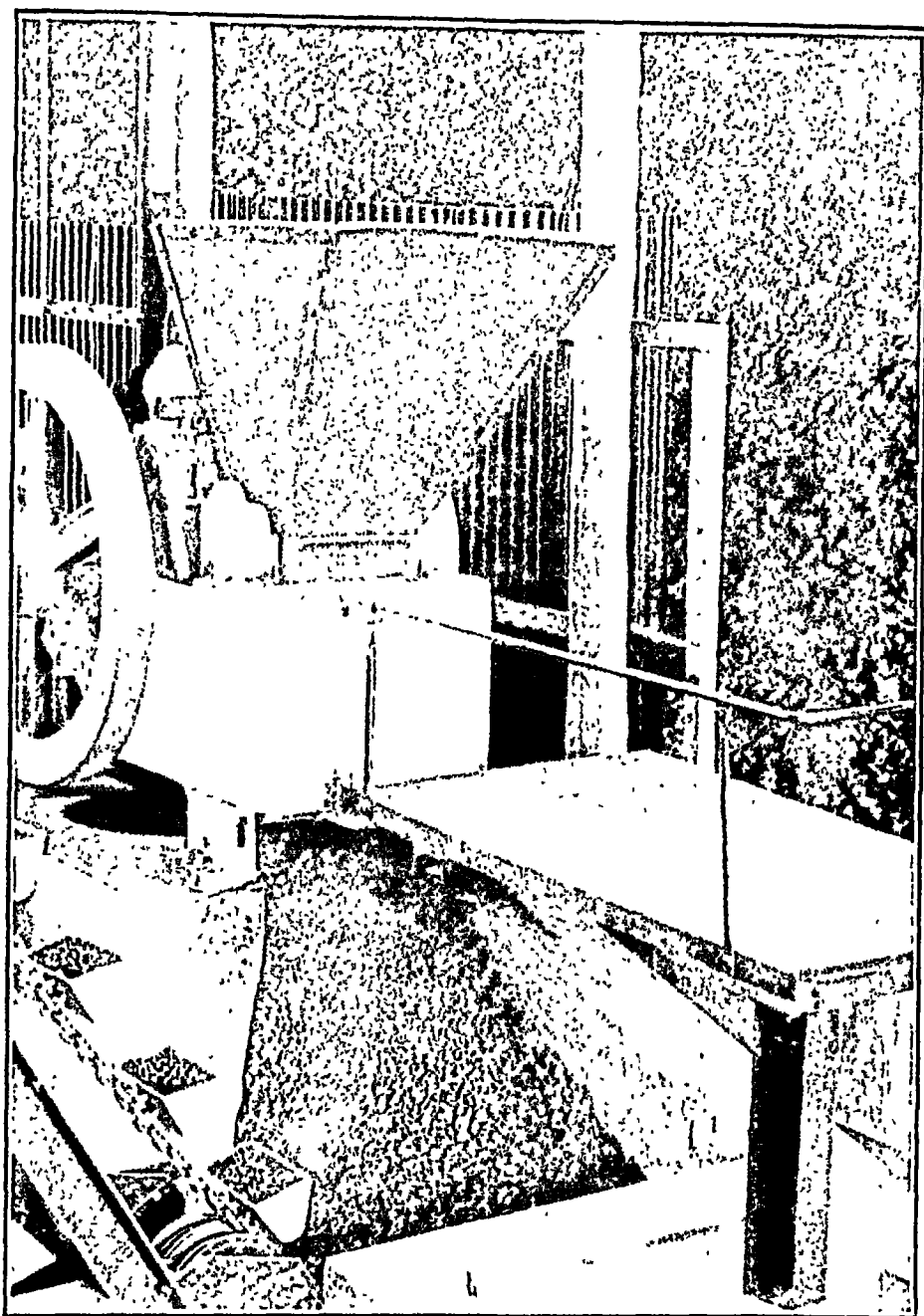
(1) To prepare mixtures of this kind necessarily involves the immediate provision of an expensive plant with its requisite quota of haulage units, kettles, etc., the ordinary types of which will require an investment of at least Rs. 100,000 which would need to be written off in 7—10 years.

(2) A competent, experienced technical and trained staff has to be provided and an idea of the monthly expenditure incurred in providing staff for an Asphalt Plant of a capacity of, say, ten tons per hour, would be approximately Rs. 5,500 per month.

Cold.

(1) There is no need for any party engaged in laying Asphalt Roads to burden themselves with expensive machinery. An entire "Cold-Mix" plant costs not more than Rs. 7,000, and, taking into consideration the absence of high temperatures during the process of manufacture, the life of the machinery is almost doubled.

(2) No trained or extensive staff is required to work the "Cold Plant." A gang of some ten men on the plant and another six men on the road, should be sufficient for laying about 600 square yards of 3 inch thickness of "Cold-Mix" per day of 8 hours. This amounts to about 10 per cent. of the labour required on a "Hot-Plant" of equal capacity.



A "Close-up."

Showing Crushed Iraq Bitumen being elevated for Pulverisation. The store in the back-ground, illustrates the condition of the natural material exactly as received from Iraq and otherwise untouched.

(3) The possession of an Asphalt Plant for "Hot-Mix" usually entails a complete reliance on the ability of several parties to supply raw materials and seldom are an unvaried grade and quality of these materials consistently forthcoming.

(4) A "Hot-Mix" will require almost 50 per cent. more bitumen than is needed for a "Cold-Mix" and since the cost of bitumen alone represents 80 per cent. of the total cost of materials, it is speedily seen that a "Hot-Mix" is excessively expensive.

(5) The majority of Asphalts employed in paving works, have their Flash Points at about 400° F. and it therefore follows that, by raising the temperature of the ingredients in a "Hot-Mix" to such a point, there is every risk of the bitumen being overheated and its binding properties jeopardised or completely destroyed. Actual experience proves it to be necessary, when working "Hot-Mixes," to keep a special individual record the temperatures of each batch of aggregate. This difficulty of temperature can be gauged from the fact that on an average sized Asphalt Plant, where 120 tons of aggregate are heated daily to a fairly high temperature, it is almost certain that, even on well-regulated units, at least 5 per cent. of this material will be overheated, and in consequence, a considerable area of pavement will be destroyed, amounting annually to a loss of no small dimensions.

(3) Every ingredient for a "Cold-Mix" and every requisite commodity of the products of the Mawson-Vernon Refinery are stored locally and constantly available and all unvarying in quality—the best and most suitable. The same remarks apply to the mechanical spare parts, or service, if you should need it, in matters appertaining to Pug Mills and the like.

(4) The quantity of bitumen needed for "Cold-Mix" is, roughly, half the amount needed for "Hot-Mix" and that with resultant greater efficiency.

(5) The complete absence of high temperatures eliminates all risks of burning or overheating the Asphalt and herein lies one of the greatest advantages of a "Cold-Mix". The risks attributable to the human element are eliminated and confidence exists that there can be no trouble forthcoming owing to the bitumen being burnt, for it never comes into direct contact with the flame heat.

(6) The rolling of the "Hot-Mix" must be very carefully undertaken, for, should the material cool to below 260° F. it will be found impossible to rake or roll it and obvious loss results.

(7) All material which is cut out of pavements, road surfaces, etc., is completely wasted when trenches are opened for Utility Works, as it cannot be re-used. This represents a very considerable loss to the Utility Companies concerned for trench reinstatement and repairs.

(8) It is far from economical to carry out repair works with "Hot-Mixes" with a plant working at about 10 per cent. of its normal output, the Asphalt having to be heated several hours in advance.

(9) It is well-nigh impossible for the Laboratory to keep, in the case of a "Hot-Mix," a check as to the proper maintenance of required proportions. An extraction requires from 6 to 24 hours and during this time the mixture has been raked and rolled on the street.

(6) It is quite immaterial whether you lay "Cold-Mix" to-day, to-morrow, or next week. It is always ready for you; ready to do its final part as soon as you spread and roll it. The traffic thereafter will add its daily quota in the direction of furthering the consolidation.

(7) Repair work and trench reinstatement can be taken in hand with the greatest of ease and traffic turned on within an hour after completion. If the "Cold-Mix" material forming the road surface is carefully preserved, it can be used over again, for the binding properties are never lost.

(8) No waste results as in the case of "Hot-Mixes," when a little over-production at the plant has taken place or when the "Hot-Mix" has gone cold, or, again, in the cutting back of joints and rejecting of "balled" material.

(9) In "Cold-Mix" preparations the Laboratory check is continuous; at the time of manufacture, of laying and when completed. Under this heading the "Cold-Mix" cannot go astray.

The longer a "Cold-Mix" surface stands subsequently to rolling, the more it improves, whether it receives the traffic it is designed for or not. This is ensured by the slow setting of the road surface, due to the almost imperceptible volatilisation of the small percentage of Flux Oils introduced, which ensures a more "plastic" surface, instead of the pavement going entirely to pieces when there is no traffic, as in the case of Sheet Asphalt or other "Hot-Mix." The only way to overcome this would involve the flooding of the "Hot-Mix" with Bitumen and risk the pavement degenerating into a series of waves.

It must be understood that each grain of sand in a "Cold-Mix," is entirely surrounded with extremely fine particles of Natural Asphalt Powder which adhere to the sand for the reason that the sand is first coated with a special flux oil. These fine asphalt particles agglomerate into a solid body when the aggregate is rolled.

The bitumen in a "Hot-Mix" is more difficult to incorporate evenly, owing to mechanical difficulties, than is the case with Asphalt of a "Cold-Mix" which is introduced in pulverised form.

Cold-Mix can be prepared and stored in the open or in bags, etc., for weeks, if necessary, without any fear of the mix deteriorating in any way.

Nothing is more simple to manufacture and lay than a "Cold-Mix" surface. It saves time and the cost of labour and fuel when compared with an "Asphalt Hot-Mix" and will last equally as long under similar traffic conditions.

CHAPTER VI.

WATER-BOUND HIGHWAYS

AND

IRAQ BITUMEN.

AN impression may perhaps have been created that "Cold-Mix" is only suitable for the formation of new road surfaces of some 3 inches of consolidated thickness. Such an impression would be entirely erroneous.

To illustrate this, it is desirable for a moment to consider the reason why that type of India's present highway,—the water-bound macadam road,—in the United Kingdom, with its infinitesimal rainfall compared with parts of India, ignoring for the time being any parts subject to excessive drought, is either a thing of the past or almost doomed to extinction, except, of course, in the case of country lanes and even these are being used more and more by the motorist.

The moment sufficient funds are available, water-bound roads in Great Britain will be transformed into surfaced or surface dressed roads, by which latter means the dust nuisance is more or less expunged. The former method, by the creation of a crust, renders a roadway immune from surface water percolation, thereby eliminating the greatest cause for repair work. A water-bound road, composed of stone possessing even the highest of cementation values, is quite incapable, in wet weather, or very dry seasons, of withstanding the extreme suction created by fast running rubber-tyred vehicles. Similarly, its powers of resistance are unable to cope with the pressure or impact imposed upon the road in like circumstances, and the "pull" and "push" actions, arising from propulsion and, equally, the application of brakes, with heavily laden types of motor lorries, tractors and trailers.

What then are the substitutes to be provided for water-bound roads and for what reasons are the changes justified?

Wherever possible and where such factors as camber and "kerb" depth available permit of such a course, it is better to regard the old water-bound road as foundational, pure and

simple, and superimpose thereon a surface of treated stone to a consolidated thickness of 3 inches if funds permit. Increased weights necessitate increased bearing powers, and such a treated surface of tar macadam or tar and bitumen macadam, although it possesses necessarily a distinct disadvantage as compared with a 100 per cent. bitumen road, is, at least, when properly made and laid, capable of resisting its greatest enemy—surface water. The penetration of water ultimately destroys any road surface subjected to modern traffic conditions and present-day speeds and weights.

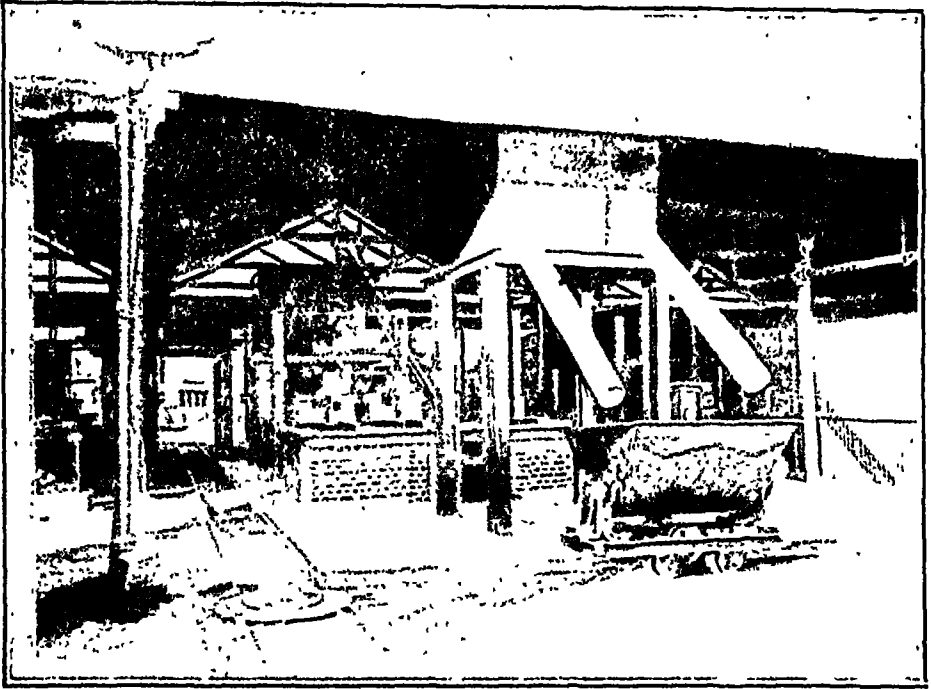
The cost, also, of such surfaces is reasonable at the inception, but annual surface dressing is necessary, for tar, from the very day it is heated to an adequate temperature to be applied to the stone, starts to lose those volatile properties upon which it depends for its tenacity, and exposure to the atmosphere and rain completes the process of gradual oxidation.

It is, of course, sometimes impossible to superimpose as great a thickness as 3 inches without dangerously increasing the camber or decreasing the kerb margin beyond one of safety.

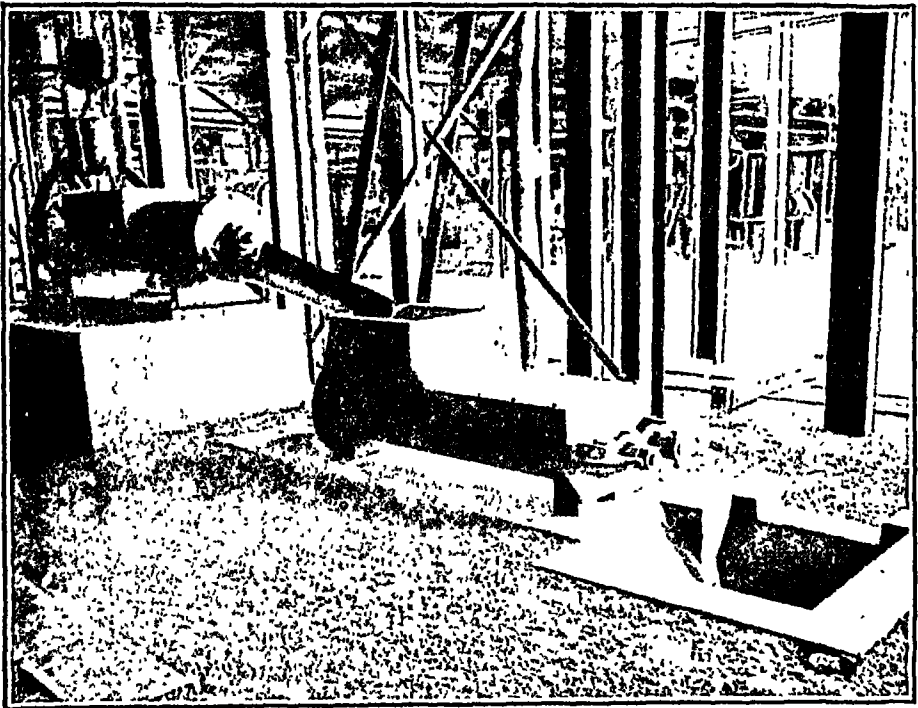
The importance of reinforcing Coal Tar as a binder, with as high a percentage of bitumen as is practical, cannot be too highly emphasized. The strength and life of a road largely depend on the strength of the binder, its power to frustrate movement and its ability to render the road surface impervious to water. There is a maxim in the Road World which cannot be overstressed: that a good road surface is one which always remains dry from its capacity to resist the penetration of water.

Another substitute for water-bound surfaces is found in bituminous preparations and carpets of 2 inches and even 1 inch thickness, but none of these can be manufactured cold throughout with an unheated bitumen, as is the case of the Mawson-Vernon Natural Asphalt, and by means of a plant which represents the acme of simplicity and portability provided at a minimum of expense.

The amount which has generally to be computed for interest on capital alone, in a bituminous carpet plant capable of producing say 100 tons per day of 8 hours, would, in itself,



*Pulverising Battery and Storage.
Iraq Bitumen is rendered the more tenacious by being ground to
powder, in fact, it puts 'New Life' into his system.*



Simplicity. A Stationary Type "Cold-Mix" Plant.

be adequate to purchase outright in one year, a Mawson-Vernon Cold Mix Plant.

It is true that in Great Britain, palliatives are introduced where funds preclude the real necessary remedy for a water-bound road, but such treatment as surface dressing with tar, or emulsion of water and bitumen ; grouting or semi-grouting by hot processes, are quite outside the pale of practical politics for a country like India. It is futile, therefore, to contemplate their uses, if durable lasting surfaces are to be provided in the Peninsula.

While seeking the solution of the problem of water-bound roads in India, it will be remembered that, frequently, little annual progress is made, in fact, cause for congratulation may almost be said to exist if the position at the end of any given year is *in status quo*, and the elements of sun and rain have not succeeded in establishing a retrograde movement. Naturally this state of "maintenance," even of a stationary order, cannot be achieved without the expenditure of vast sums of money.

How can India, then, ensure progress, rather than the reverse, and with an annual and constant saving of funds coupled with an improved state of efficiency?

The answer is, by deciding upon a programme of a definitely determined policy to tackle the question of the water-bound road as a problem which has to be vanquished by the adoption of modern means, without that increase in expenditure which modern means usually entail.

India's water-bound roads require to be kept in their place.

"How can this be done?"

"By providing a binder."

"What Binder?"

"Bitumen."

"What Bitumen? We have no fuel to heat it and insufficient water available to drink, let alone to spare for road surfaces."

"It is unnecessary to provide either heat or water. The Mawson-Vernon "Cold-Mix" Pulverised Asphalt can be sent to

you, you can do the work with your own labour and the Mawson-Vernon Company will instruct you in the simple methods of manufacturing the material on the site, so that there may be no mistake and so that past experiences with hot asphalt, may not tend to create confusion in the use of "Cold-Mix." Hot and Cold are as dissimilar as the Poles or the positive and negative forces of an electric current. So is it with Hot mixes of Asphalt and the Cold Pulverised Iraq Asphalt."

Picture, for a moment, a consolidated 1 inch or $1\frac{1}{2}$ inch solid stone filled bituminous crust, superimposed upon the present water-bound road. The rough angular face of the latter forms a perfect key for "Cold-Mix." You have a silent, dustless surface which the sun cannot injure or impair, neither can the rain penetrate and wash away your chippings, sand and earth filler, as it does to-day, when the scour of the monsoon cuts the very core out of your water-bound roads.

A consolidated 1 inch coat which can, if desired, be added to in thickness, as time passes, will initially cost no more, hardly, than the average sum spent annually on maintenance and watering, and the dust nuisance ceases to exist.

These advantages apply not only to water-bound roadways but to paths, grounds, railway yards, platforms, warehouses, in fact anywhere where an impervious, silent, dustless and indestructible surface is required.

The Mawson-Vernon "Cold-Mix" is to a water-bound road, what armour plating is to a war-ship. It protects from outside influences, those vital parts which are otherwise vulnerable, being susceptible, in the case of the roadways, to destruction through the ravages of heavy and fast moving traffic; the loosening propensities of surface water which destroys the very factors which bind such a road together, and, the sun which turns that cementing force into dry dust which is then only a filler, not a binder, and which every passing motor car whirls away in blinding clouds.

It can unhesitatingly be claimed that it is a sound and economical policy to profit by other peoples' experiments, and, by a process of deduction, determine which of those methods are advantageous and which must be eschewed.

It will be granted that the information offered to the Road Engineers of Public Bodies in these chapters, at least affords them in some detail, experiences and data of actual processes carried out in other parts of the world, which may, in some degree, assist them with their own particular knotty problems. This hope, at least, is expressed.

If the advice of the Mawson-Vernon Company was sought as to "the best method of keeping the water bound roads of India in their place" their recommendation, in the majority of cases would be, "Protect your road surface with 'Armour Plate', that is, with a wearing surface which the sun cannot move or disintegrate; the rain cannot permeate, and which will be of such a nature that dust will not result therefrom."

We interpret the term "best method" to mean the most efficient process whereby the object in view can be economically achieved. The only really effective and economical method suitable for India's roads, is an applied wearing surface coat of Natural Iraq Asphalt "Cold-Mix."

No doubt the retort in some cases would be: "But what about the expense?"

The Mawson-Vernon Company emphatically asserts that the expense, initially, in many cases, will not exceed the present average total annual sums expended by districts upon each square yard of water bound macadam road, and ultimately, within a year or so, the annual expenditure will be modified by a reduction of, at least, one third, and finally, with continued treatment, by half.

In a few cases where it may be necessary during the first 12 months to spend perhaps an additional 2-4 annas per square yard, that expenditure, in the second year will not only be recouped but a substantial saving over and beyond that repayment will be apparent.

It may reasonably be that districts here and there may require to accrue reserve funds before they can adopt a system of road surfacing, extending, necessarily, over a given number of miles annually and for which definite sums of money only are available.

In such circumstances, the Mawson-Vernon Company advise that the present water-bound roads be impregnated with Road Oils and a surface coat of fine $\frac{3}{4}$ " to $\frac{1}{4}$ " metal, local stone, etc., or whatever is available, treated with Iraq Asphalt Thermal Primer be rolled into the interstices of the road surface. That course will preclude the annual expenditure in making good the yearly incursions made by rain and sun into the body of the road and the cost of constant watering. Ample economy will result from such a measure to enable a wearing coat of "Cold-Mix" to be applied at a future date upon the very roads which, by reason of the treatment with Road Oils, have been prepared precisely for such a step, and, apart from that aspect, there are immediate benefits which result from the same source: those of coping with the present recurring troubles.

The use of Road Oils is simplicity personified. Scarify your surface, remove the metal and aggregate material, and treat the sole of the road, thus exposed, with Light Road Oil.

The metal and aggregate are then mixed by hand at the road side with Heavy Road Oil and replaced exactly as would be the case with Tar Macadam, say, and rolled into position.

The ultimate treatment depends upon the method selected. If a "Cold-Mix" coating is to be applied of, say, $\frac{3}{4}$ " consolidated thickness, the metal and aggregate surface will be completely rolled and the "Cold-Mix" surface then applied.

If, however, no further wearing surface is deemed necessary or desirable from one cause or another, Iraq Asphalt Thermal Primer Coat is used as an ultimate seal, blinded with grit, sand or gravel, and the road may then be opened to traffic. As soon as the blinding material has vanished through the effects of traffic, that road will remain free from dust for 18 months to 2 years and at a very small cost.

These several Processes therefore provide surfaces which must surely meet the needs of all Roads and at an expenditure which will conform to all annual estimates in proportion to the amount available to be expended per square yard in any project.

The Engineer of each Public Body, therefore, has a choice of either a "Cold-Mix" surfacing coat of $\frac{3}{4}$ inch to 3 inches consolidated thickness; or a surface of his own Macadam treated with Road Oils and a coat of $\frac{3}{4}$ inch consolidated "Cold-Mix" superimposed thereon; or he may, alternatively, substitute for "Cold-Mix" a sealing coat of Thermal Primer Road Oil mixed with his own road materials.

CHAPTER VII.

DUST!!!

"THE BOGEY OF THE ROAD IN INDIA, AND ITS PANACEA."

Iraq Bitumen.

LEAVING, as it were, the heights of Olympus, so far as roads are concerned, when we ended our treatise upon the benefits and advantages to be derived from the use of "Cold-Mix" Pulverised Asphalt, we must now descend to the plains and cannot fail to notice the real need in India for an efficient dust cure.

There are several prominent factors to be considered here. The first is the magnitude of the undertaking in treating the thousands of miles of surface needing a remedy for the whole of India's most evident and prominent road nuisance—Dust!

The theory might be advanced that there are several ways of overcoming this pestilent and unwelcome companion of the road. Let due consideration be afforded to a few of the obvious: Gas Tar, Bitumen Tar Compounds, Hot Bitumen, and Cold Bitumen in colloidal form emulsified with water.

Prior to dealing with these suggested commodities, it is probably well-known that all of the above in varying proportions are in use throughout the United Kingdom, and it will be readily agreed, no doubt, that the roads of that country—the policy governing them having received the particular consideration of such an eminent Director as Sir Henry Maybury—are, taken as a whole, unsurpassed by the roads of any other country in the world.

It must also be remembered that in spite of the fact that the islands contain approximately only 200,000 miles of road way, the traffic conditions in many parts are intense.

Given these preliminaries and assuming for one moment that the Solar conditions of India and its rainfall were prevalent in the British Isles, then with the exception of Hot Bitumen of appropriate penetration, it is quite possible that none of these preparations would be applied to the roads. Even as it is, 70° F. in the shade is adequate, generally, to justify head lines.

in the newspapers about the "heat wave" and the sun is quite sufficient to give cause to motorists to complain justifiably of the annoyance and damage they experience from tar which is picked up by the tyres of vehicles with the greatest ease when first laid. Rain, however, soon removes the blinding grit and sand, and the nuisance, like the tar, frequently disappears.

Bitumen tar compounds, necessarily, are better, but a sufficiently high percentage of Bitumen admixture for Indian roads is difficult to obtain, apart from the undesirable necessity for providing heat with such products.

India's roads do not need a film or skin of waterproof; they need far deeper treatment; far more lasting preparations; far stronger surfaces even than a hot bituminous semi-grout, and, above all, India needs a tenacious binder capable of holding not only the surface chippings but also the road metal in position; a binder which will, without question, resist the utmost effort of the heavy rainfall to destroy the entire surface, and all these requirements need the proviso "without heat."

Such preparations are forthcoming in the Mawson-Vernon Natural Asphaltic Road Oils.

There is one interesting fact which may well be recorded here which shows the proved inferiority of tar to resist water and the impossibility of making bitumen unite with water. Tar, as everybody knows, is generally dehydrated, proving the presence of water as one of the standard components, but, when an endeavour is made to emulsify tar and bitumen in water, the bitumen forms a waterproof covering to the tar itself. This shows, therefore, that bitumen and water cannot combine, for bitumen has a natural aversion to water which it resists.

Before we turn our thoughts in the direction of Road Oils, a few moments devoted to the subject of Bitumen emulsified with water, may not be regarded as wasted time. The usual maximum binder content is 60 per cent. in 40 per cent. water; and, even in that proportion, there is a danger of reversing the order and of obtaining water in suspension in bitumen, which is, of course, a hopeless state of affairs.

The last two years in the United Kingdom, have seen an almost disproportionate increase in the number of products supplied under the nomenclature of Bitumen cold emulsions.

Fortunately, the Mawson-Vernon Company is particularly conversant with the work undertaken with Cold Emulsions in India, Great Britain and elsewhere and the limitations of that class of commodity are well known to the Directorate. Apart from this, however, even were these emulsions an unqualified success under the climatic conditions obtaining in Britain, which they assuredly are not, it is certain that the climate of India would speedily prove, beyond question and doubt, that, for the roads of India, an emulsion of Bitumen and water is absolutely unsuitable both from a point of view of expense and the results, if any, obtained.

What possible service can a thin film of bitumen, used as a water surface dressing, be to India's roads? Forms of emulsion in Great Britain are still forthcoming, which are added to the water sprayed by water carts, the result being bitumen in a very diluted form, and which, it is claimed, is an efficient dust allayer, but the application, of course, has frequently to be repeated.

The primary claim for emulsions in Britain is that they can be used under damp conditions, when hot preparations cannot be applied, and a very sound claim it is, for it saves money often wasted through the varying uncertainty of British weather. In India, however, there is sufficient dry weather in most parts to enable the roads to be surface dressed if it was so desired, once every month for at least nine months in complete confidence that no delay to hot dressing would result from rain.

Unquestionably an indestructible binder is what is needed to improve and hold together India's roads. Of water she has ample during the monsoons. To apply therefore 6 gallons of Bitumen of a base generally obtained from a residual commodity, and four gallons of water in every ten gallons of colloidal emulsion, means that payment on ten gallons of "binder" is being made, for 6 gallons only actually provided to attempt to help to hold the road together or protect it from surface water. The actual

cost of the "binder" therefore is almost half as much again as the quoted price.

The chief use in Great Britain for Bitumen Emulsion is certainly for surface dressing, but its reputation is waning, it is thought, firstly upon the grounds of cost compared with the price of good Road Board specification tar and tar compounds, as well as from the lack of results.

Secondly, because of the impossibility of obtaining a really high percentage binder content. Thirdly, because of the tendency it has to be affected by frost in the winter. Once the dispersator, enveloping the minute globules of bitumen, is cracked, the bitumen emerges, links up with other globules similarly liberated and the whole form an intractable mass which is a source rather of danger than of service on any road.

Finally, because of scepticism on the part of the Public Road Engineers and Surveyors, attributable to the number of emulsions, good, bad and indifferent, which are being added to the original two or three. Further cause lies in the fact that there have been extensive instances of failure on the part of several of the best known emulsions to adhere to main road surfaces and, in one case, almost a quarter of a million square yards were involved. The supervening conditions baffle description. Binder and grit, attaching themselves to the tyres of traffic, were carried distances of anything up to ten miles and deposited as soon as sufficient oxidisation had taken place. The road surface was studded with giant "limpets," as it were, which required a chisel and hammer at times to remove them and which became a real incubus to the drivers of fast moving vehicles.

This particular work was carried out in the late autumn and it was thought—though never apparently actually determined—that the cold early morning moisture had prevented the binder from attaching itself to the road surface before the traffic commenced to lift it in strips. That, of course, proved the last straw, for the tyres coated with tacky bitumen were then exerting even a greater adhesion and, ultimately, the only step to be taken was to blind the road as thickly as possible with

insulating grit and employ a gang to remove the "balled" material thus formed.

It is, of course, an admirable endeavour to coat stone with bitumen as a binder, exactly in that proportion which will prove adequate and neither superfluous nor deficient. Seeing however that, with broken stone, the superficial area to be coated in a given weight of, say, a 16 cwt. batch, or a given area of a square yard 3" thick and unrolled, must necessarily vary because of the ever-changing angularity and the difference in aggregate proportions, the endeavour is one which has a certain element of luck necessarily attached to it.

Apart from this aspect, however, there is one outstanding drawback with bitumen in suspension in water applied to a road as binder.

Rarely can road stone be said to be clean and free from dirt of a damp nature or dust, after it has been rolled into a road. Even the slightest presence of either on the surface of a stone is adequate to frustrate the attachment of the binder to the stone. It adheres to the dirt on the stone but its tenacity forms an alliance with the dirt and pulls away the dirt itself from the very stone which its purpose is to bind to another. Similarly the slow setting power of this class of binder is such that if movement takes place under traffic and any surface water penetrates before the actual binding of stone to stone takes place, the elastic nature of even such minute particles, collectively is sufficient to allow a film of dirt to be left by the passage of surface water and again insulation is the natural sequence. "Slow" and also "Quick" setting emulsions in consequence are being manufactured, the latter naturally containing less fluxing material.

Bitumen in this form is distinctly a clever production; it is also of material assistance as has already been admitted in cases where weather conditions preclude hot surface dressings but somehow or other the mere fact of splitting up a fluxed bitumen into minute fluid particles, enclosing each in an envelope of dispersator and suspending them in water seems to rob the bitumen of its original power and unequalled

binding properties, for bitumen in emulsions never seems to harden in the same degree as non-emulsified bitumen when employed as a Road Binder.

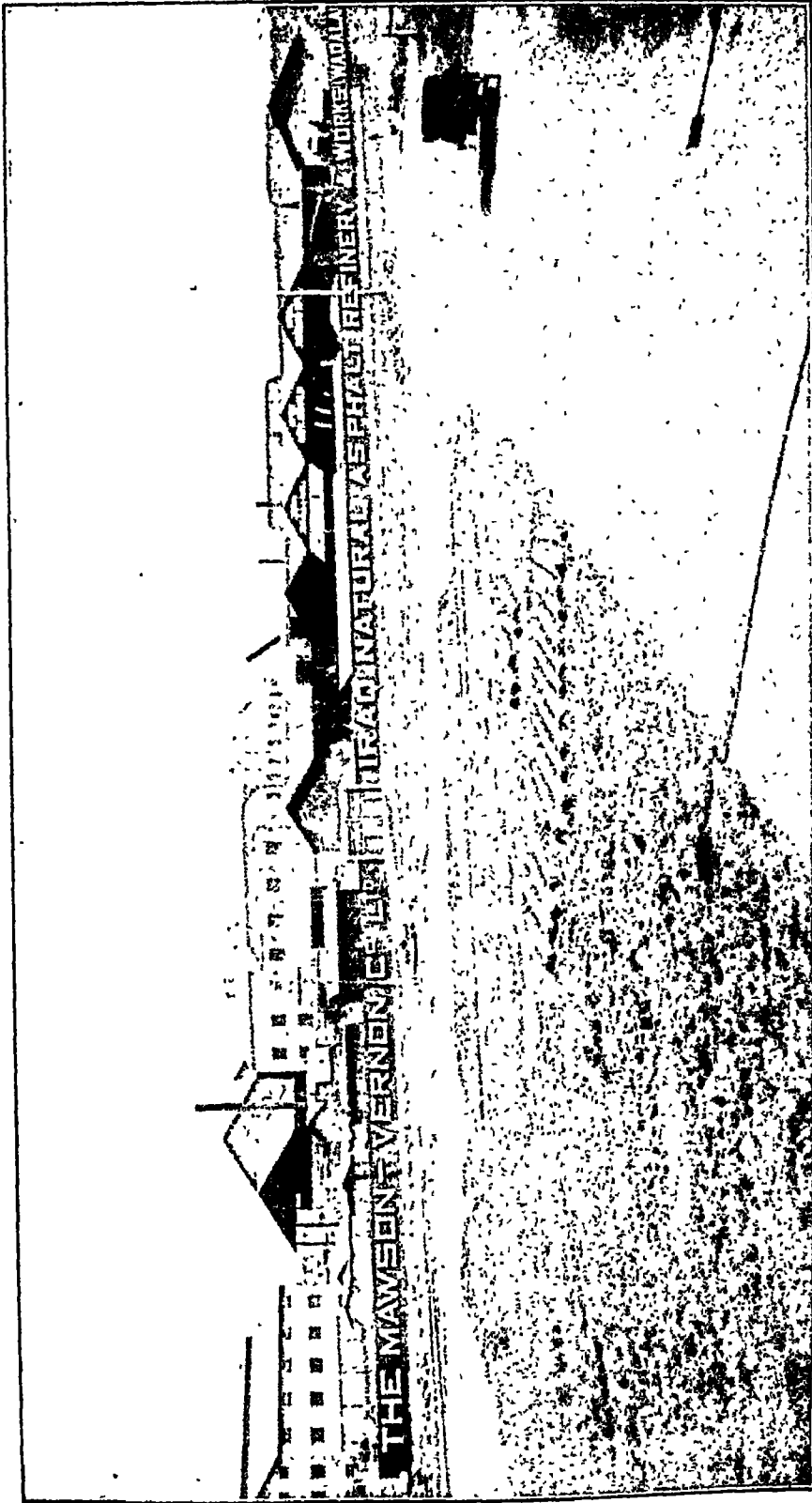
But apart from all contingencies, it can never be considered in Great Britain as a serious competitor to, say, good tar macadam with a small percentage of bitumen added. Prove this by an example: A ton of ordinary road metal will cover $7\frac{1}{2}$ yards super when rolled to 3" thickness. If the tar be really good and provided the surface is kept watertight, this road will last 5 years as a minimum. The cost of the tar binder here would be $6\frac{1}{2}$ gallons at, say, 6*d.* per gallon or 3*s.* 3*d.*

To treat $7\frac{1}{2}$ square yards of 3" consolidated work would require one gallon per square yard originally, $\frac{1}{4}$ gallon per square yard three weeks after the final rolling and $\frac{1}{4}$ gallon sealing coat, $1\frac{1}{2}$ gallons per square yard at, say, 8*d.* a gallon or five shillings per $7\frac{1}{2}$ square yards for binder. Apart from this, such a road, after six months, should be given a further dressing of one gallon to 4 square yards — and the manufacturers will recommend it.

Good tar macadam in the United Kingdom has been known to stand 23 years, and although, of course, completely oxidised, that tar, until the seal was broken, formed an exceptionally good locking power. Bitumen, unless burnt, through the application of undue heat, never oxidises.

Nearly two years ago, a prominent publication of the Civil Engineering World in England, contained an article which prophesied that in a few years, almost all road binders will be supplied in a cold state. Bitumen was not exclusively specified but the clairvoyance of that author seems to have foretold the advent of Cold Iraq Bitumen — The Binder!

Whatever may prove to be the future, or otherwise, of bitumen and water emulsions in Great Britain, it is a certainty to thinking Engineers and those in a position to judge from extensive practical experience, that no such preparation can withstand the demand India's roads will make upon it, neither can it be of service to her.



General View of Refinery and Works, Wadala.

CHAPTER VIII.

THE WORKS AND REFINERY.

It would admittedly be a reasonable question, on the part of anyone conversant with the conditions which generally obtain in the direction of the supply of binder material for the surfacing of the bituminous roads of to-day, to ask, why, at the initial stages, Works, Refineries, Laboratories, etc., occupying over four acres have been erected and completed.

The answer briefly is this. The sun has set on the day when it was considered adequate for a company to supply one or two of the essential components of a bitumen surface and leave it to the Body responsible for that road, to make the best they could of the undertaking, with the aid of a few, too often, alas, rule of thumb suggestions.

During the year 1927, Professor Irvine Masson, M.B.E., B.Sc., F.I.C., of the University of Durham, Great Britain, drew attention to the unsatisfactory state of affairs, so far as road makers and those responsible for the maintenance of roads were concerned, having to employ ready-made products, as it were, manufactured by people who did not themselves use them. That is a factor which applies very largely to manufactured articles in general. If people who make them, had to use them, they would, doubtless, produce something really suited to the needs of the purchaser ; for the manufacturer can only glean information as to what the purchaser wants, from what the purchaser himself explains, and not from his own practical experience.

Judging by India's experience in the past, the modern establishment which will satisfactorily assist in coping with her road problems, is one which is permanently located within her boundaries, and, further, one which is adequately equipped in the direction of personnel and machinery.

Road-making cannot be achieved successfully, even with the best materials which can be provided, without the constant availability of chemists, engineers and others who have spent years in training and gaining that daily practical experience which in road work, is worth a life-time of theory.

The knowledge of modern Roadway Engineering can no more be communicated by pamphlets to others who are in need of it, than modern surgery, and its principles and operations – (to learn the rudiments of which a student devotes initially some 4 or 5 years) – can be communicated by means of a published hand-book, to a ship's engineer faced with the problem of the removal of the appendix of a passenger or member of the crew, at sea.

Engineers of Public Bodies, – who, by virtue of the restricted areas under their jurisdiction, – and who, also, by reason of the present day multifarious branches of engineering with which an engineer of the average Public Body has to contend – naturally, have often been precluded from obtaining that modern experience which another engineer can achieve by devoting his whole time to the study of Roads.

It is both by the permanence of the Works and Refineries situated in India, and by the provision of specialised assistance at the hands of chemists and others who have spent years in the service of Roads, that the Mawson-Vernon Company is now in a position to fill what was, apparently, always a real need in India in the past.

The provision and erection of a Works based upon actual road experiences extending over many years, is a *sine qua non*, if real efficiency is to ensue ; if the maximum amount of service is to be afforded to customers, and the highest known forms of bitumen road making materials are to be forthcoming for use by Public Bodies or the manufacturers, according to the conditions prevailing.

Furthermore, apart from the sense of security which must surely result from the creation of such a manufactory, it eliminates entirely, by virtue of the continuous services of those trained in the physico-chemical principles underlying the uses of their materials, anything in the nature of costly and protracted experiments on the part of Public Bodies.

Formerly, road binding materials were usually supplied in a number of barrels and drums. The contents of these may reasonably have been manufactured many thousands of miles away, with the result that any experiments to test the qualities

claimed for those contents, if they failed to achieve their reputed ability, had, in any case, no stake in the country, as it were. Now, however, there is a large Refinery with its affiliated Works and attendant Laboratory actually embedded upon Indian soil.

The magnitude of the Works therefore stands for "SECURITY"; that of the Public Body; that of the road surfaces themselves, and that of the manufacturers, in the faith they possess in the full and certain knowledge of the efficacy of their manufactures. Such three-fold security is cyclic, and in circles, as in the Mawson-Vernon products, are the highest known factors of strength.

"Cold-Mix" surfaces may be accepted, therefore, without any need for hesitation or temerity on the score of untried materials. They are made in a Refinery which probably is of unique design; from a natural bitumen the like of which has never been known to the road world within the memory of living man; by plant which has been designed throughout, not by plant manufacturers, but by those who have both operated and maintained road making plants for years, and for the express purpose of producing the first real "Cold-Mix" Asphalt road surface the world has ever known. The whole process is the outcome of the combined experience of those duly qualified to determine from actual usage, what are the present day needs of the road world in India and elsewhere. Without question herein lies an ample meed of security.

It is hoped that the foregoing may to some extent be regarded as an adequate apologia for the magnitude of the Mawson-Vernon Iraq Asphalt Installation at Wadala and for which, incidentally, plans for additional extensions have already been considered.

Let us, however, briefly touch upon the construction and functions of the individual items of plant as at present constituted and, in order to portray a mental picture with due perspective, it behoves us to commence with the internal store of natural Iraq Bitumen, for an external store of some thousands of tons reserve is in process of creation.

The uninitiated visiting the Refinery and Works, would probably pass by this store of precious bitumen without so

much as a conscious glance, for, superficially, it is sufficiently dull and uninteresting in appearance to mislead anyone. With no other pure natural unrefined bitumen would this outdoor stacking and exposure to the sun be possible, but the Mawson-Vernon bitumen is totally oblivious to those conditions which cause similar fragments of other natural and residual bitumens to soften, spread and assume eventually the form of one coagulated mass.

This Iraq bitumen, exactly as it is received from the Mesopotamian Plains, is passed through a crusher which reduces it sufficiently for its reception and ultimate treatment by a battery of pulverisers.

The natural Asphalt powder from the pulverisers is then elevated into storage bins from whence, by gravity, it is loaded into tipping wagons running on a narrow gauge track which, serving every part of the Refinery, is replete at all requisite points with turn-tables. Each unit of production in this section is separately driven by an electric motor. This is another factor of practical economy carried to a degree of fineness with an eye for low costs of production, which are essential in these days, when prices, with an unfortunate tendency to disregard values, are the most studied phase of road construction.

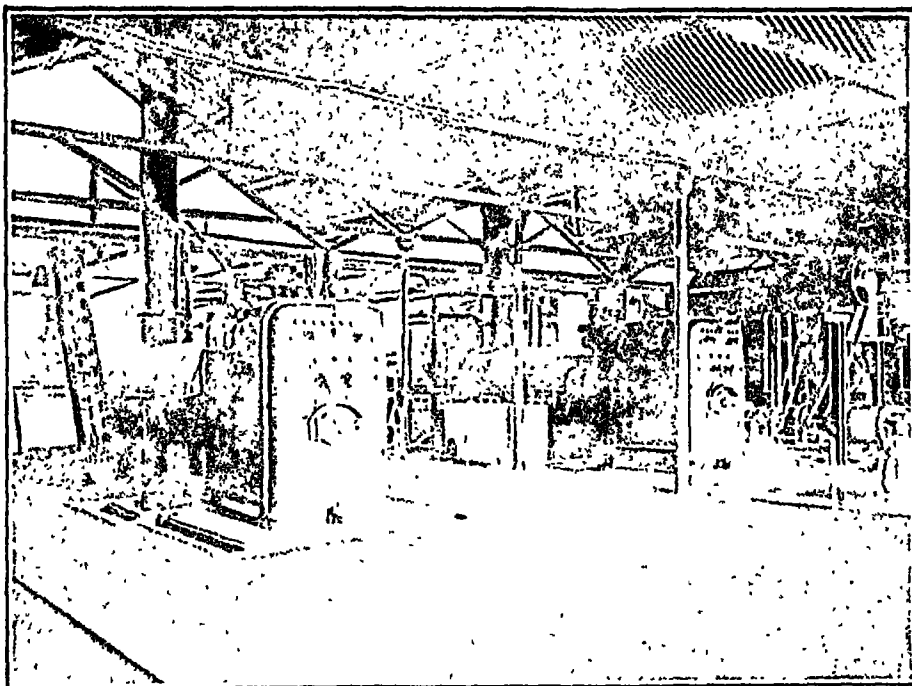
Let us however view that plant which has for its duty the production of refined asphalt. It consists, briefly, of two loco type oil fired steam boilers, which generate the sole requisite means of heating the two refining kettles with a uniform temperature throughout. There is no danger here of carbonization through the disassociation of certain of the hydrocarbon series which, in externally heated plants, results in caking effects wherever the heat is most pronounced.

The contents of these kettles are agitated by means of steam jets discharged into the interior, so that anything in the nature of oxidation, resulting from the use of air for like purposes, and the consequent unavoidable hardening of the bitumen are totally precluded.

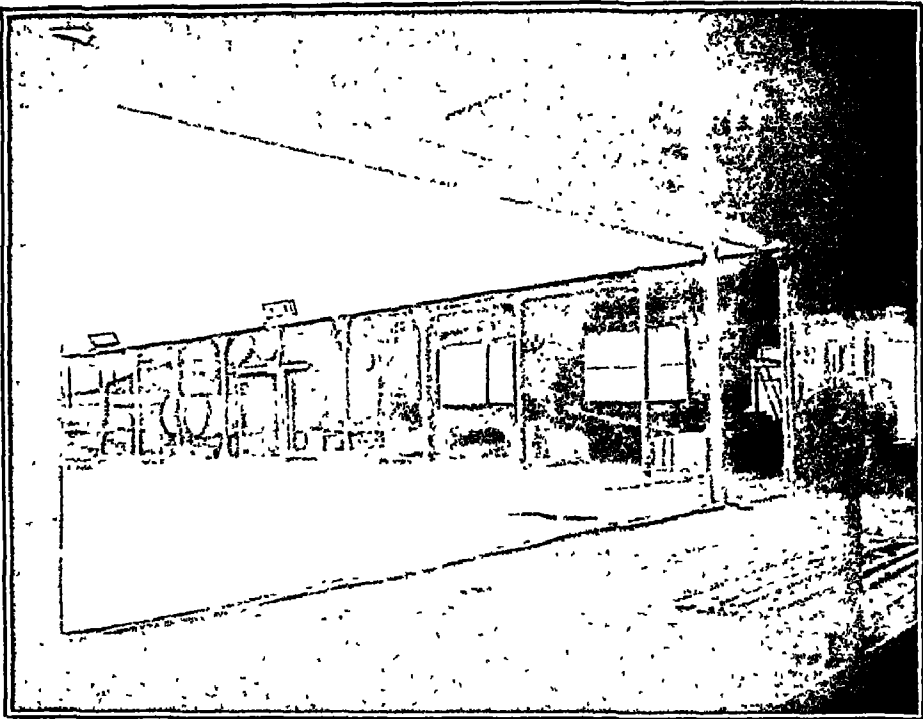
Although it may not be apparent at first sight, there are, in these kettles, silent witnesses which testify to the presence of the practical and experienced worker, who, in the



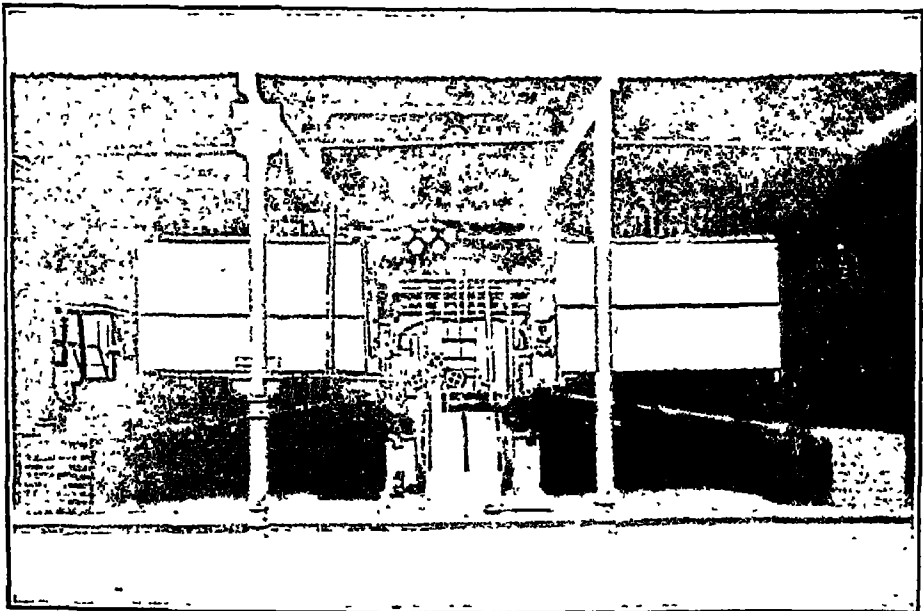
Machines for Crushing and Pulverizing—Iraq Bitumen.



Iraq Bitumen—The Binder is strictly precluded from going near a fire. These boilers generate the steam which is circulated to warm him sufficiently for refinement but he never burns.



Steam Heated Refining and Fluxing Kettles, and Oil Storage Cylinders.



Steam Heated Refining Kettles, each containing 2,500 cwt Steam Coll.

past, has bought his knowledge at a high cost and intends, in this case, to reap the benefit of his previous purchases. The length of the steam pipe employed for heating and agitation is 2,500 feet in each steam battery.

Such things as faulty seams, etc., in steam pipes are not unknown occurrences, unfortunately, and to effect a repair to one in an ordinary steam heated kettle, is not an affair of minutes, rather of days. Here, however, every section of the battery is flanged, admitting of its being speedily uncoupled and withdrawn, for every portion is easily accessible and the old bugbear of coolies chipping out the bitumen, and frequently also the pipes, with crowbars, where the contents had solidified at the base of the kettles, is not a malady which the Mawson-Vernon plant will sustain.

In addition, by the provision of a combination of steam and vacuum plants, the residue in either kettle, can be speedily withdrawn by suction and dispersed by a system of underground pipe mains to other units of plant in the Refinery available for its reception and conversion into other forms of material.

It would be to labour the subject unduly to dilate at length upon the system of valves serving these kettles, but it will be of interest and probably sufficient to say that provision has been made whereby refined and fluxed bitumen can be circulated throughout the Refinery at will, to each and every necessary group and unit of manufacture requiring this commodity, and that, in itself is no mean claim and no small undertaking.

Those whose past experiences have led them through paths which they have found hot with the thorns of burnt bitumen heated with external fires, and those who have endeavoured to keep their annual financial outlay within the boundary of the funds at their disposal for that purpose, will probably sustain slight feelings of justifiable envy in that the plant which was supplied to them by manufacturers, who made but did not use their plant, was not equipped with these simple fool-proof devices and labour-saving contrivances, each of which, when all is said and done, not only reduces the costs but safeguards the effective nature of the productions.

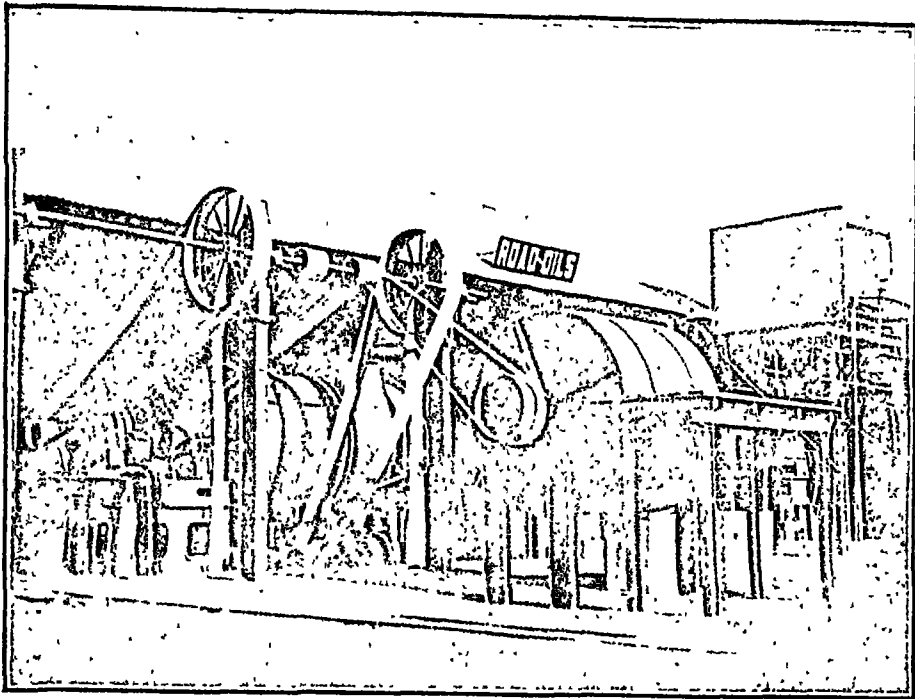
Above the third kettle, for the preparation of Road Oils, the needs and uses of which will be explained, will be seen two enormous cylinders for the reception of Asphaltic Flux Oils, and alongside are two cylinders of identical capacity for materials required in the manufacture of Road Oils. This reference necessitates mention of another group of plant units which function in conjunction with this third kettle in their production of Road Oils.

Prior to the ultimate stage of manufacture in a "Sirocco" Mixer of noble proportions, — driven by an electric motor, operated by a water dipping starter, each, in its ratio, of considerable measure, — certain of the commodities are rotated in slow time in a large circular wooden drum. This process completed, the contents are transferred to the "Sirocco" mixer from whence they are expelled to meet their fellow components and combine to form a material which will not re-emulsify in water under any conditions whatsoever, thus providing, as will be explained, a product for which the peculiarities of the road problems in India create an especial need.

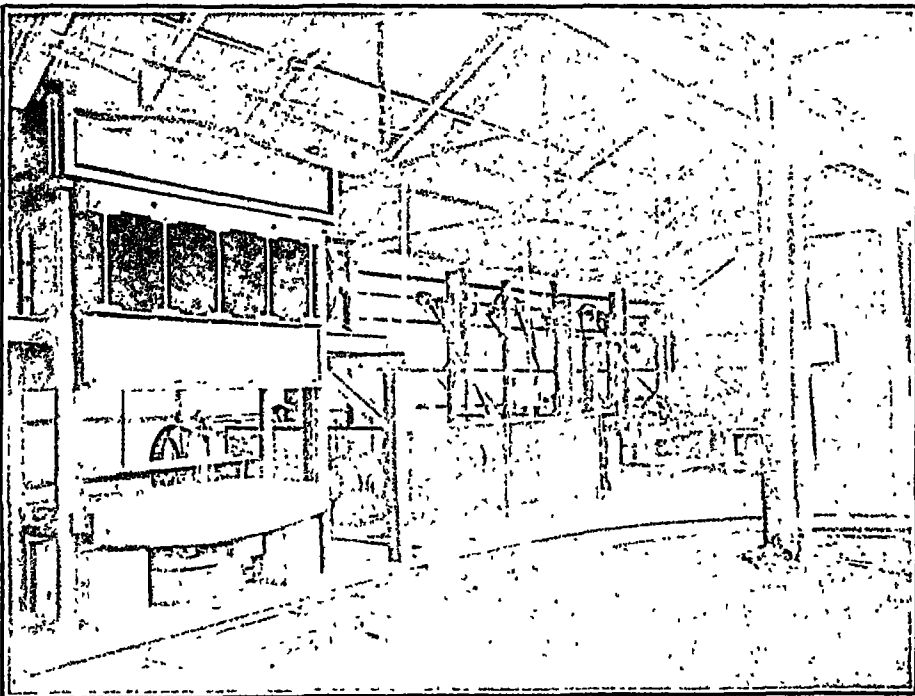
Whether it be for the abolition of the dust nuisance, or for the gradual or immediate building up of efficient road surfaces, at a cost far below that attained anywhere in India to-day, the use of this Road Oil, coupled with such road making materials as are available locally, will render it possible to overcome the annual ravages of the monsoon and the parching of the sun which abducts the very life giving properties of any water bound road and makes it more easy prey for the ensuing rain fall, constituting all the time the element of that ever present and ever apparent scourge of the traveller—Dust!

We must not, however, lose sight of that section of the plant which deals with the manufacture of bitumen blocks. Everybody knows how noisy, slippery and lacking in resilience are roads and tramway tracks paved with granite setts. A like number of people are unaware of the high initial expense of this form of paving and its continual cost of maintenance.

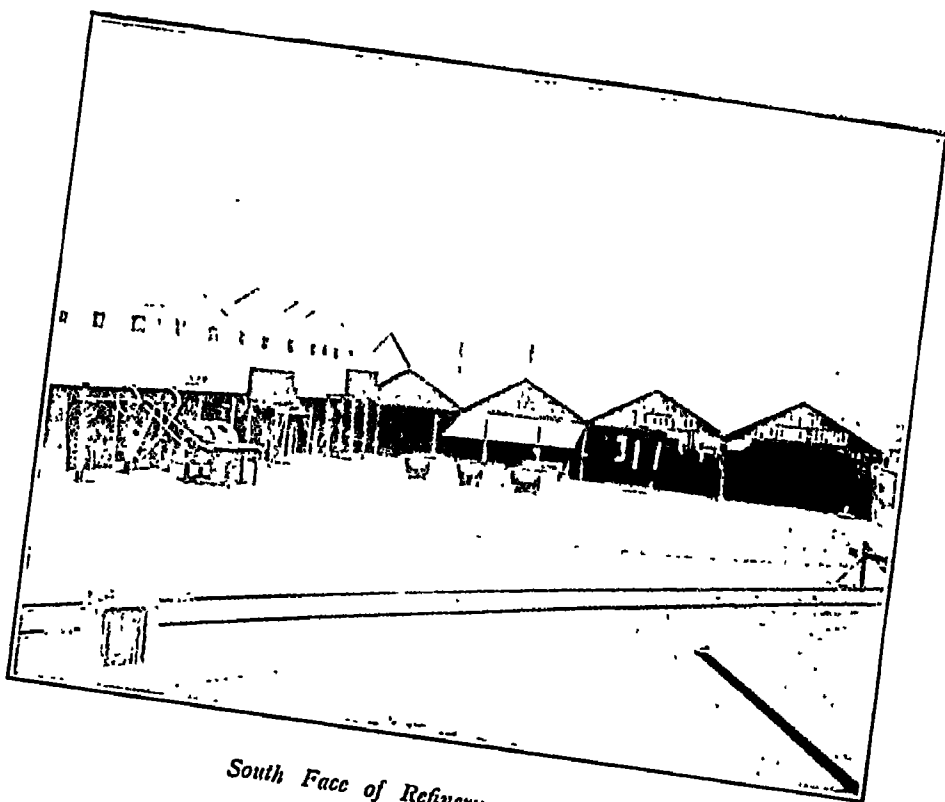
One of the drawbacks to a sett paved road, brings to mind what might be called the road maker's ideal, that is, a road of solid stone; one which would wear evenly and imperceptibly; was dustless, noiseless, and non-slippery. Such a road being



Road Oil Manufacturing Installation.



Iraq Bitumen and a burden which is very much down on him : the Press.



South Face of Refinery and Works.



Complete unit for manufacturing Asphalt Blocks and Tiles.

only obtainable in dreams, we may turn to the nearest solid road known in this more material and harder sphere of thought, — the sett road.

Setts, alas, vary in quality. Nature rarely makes two things alike, so that one piece of rock made into a sett, may have a different grain and power resistance to other setts in its immediate vicinity, and so on, with the result that an additional fault results, unevenness, and the increased noise of bumping traffic therefrom. If, therefore, from nature's bed of rocks we cannot produce the ideal, there is nothing to preclude man from endeavouring to produce an ideal road surface from nature's rocks with nature's binder, and, by exerting enormous pressure, build a road which has all advantages which setts possess and none of the disadvantages: noise, dust, uneven wear, polish and heavy initial costs and expense in ultimate maintenance.

If you will pause a moment by the hydraulic pressing plant and read the power which the press is capable of exerting, you will speedily appreciate that the weight imposed upon each square inch far exceeds that which any normally travelling vehicle is fortunately capable of inflicting for long periods on the present day road surfaces.

It only remains to visualise the process whereby these blocks or "bitumen setts" as it were, are made, to discover what the economy eventually can be to Public Bodies who maintain the roads and how great a boon to the public who travel over them.

The manufacture of asphalt blocks requires a large permanent establishment, well equipped and technically adequate to certify the suitability of the crushed and ground mineral aggregates and other appropriate ingredients. It must further be competent by virtue of previous experiences, to cope with the requisite delicate handling called for in preparations comprising the utilisation of asphalt cement.

The aggregate consisting of Stone Grit, Sand, Filler, etc., is taken from storage to a heater, which is of a type far superior to the ordinary sand dryer. This heater must be level and contains a fixed spiral which guides the material through the cylindrical drum at a uniform rate of speed and which,

while being heated, comprises a layer weighing several tons about two feet in thickness. The aggregate in consequence heats or cools slowly and the temperature can be regulated with great nicety, and as it emerges from the heater it is elevated to hot storage bins provided with suitable recording thermometers it is then ready for mixing.

The equipment for handling and regulating the asphalt cement consists of two or more tanks supplied with lifting devices. The asphalt is melted by the application of steam heat and may be refined or fluxed to the desired consistency, and agitated by means of steam jets forced up through the body of the material from perforated pipes placed near the bottom of the tanks, each provided with an accurate, stationary thermometer for recording the temperature to which asphalt and flux are heated.

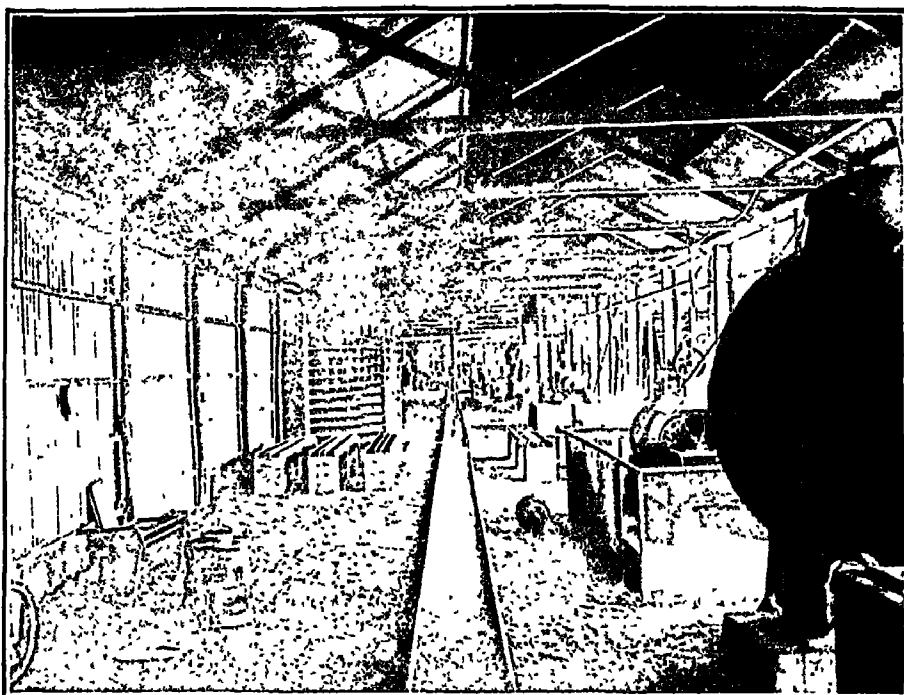
The ingredients, having been properly prepared, are delivered to the mixer platform where they are carefully weighed and proportioned for each batch according to the formula. The mixer used is a specially designed and very powerful machine, consisting of two parallel shafts geared together and carrying heavy chilled iron teeth which revolve within a chilled iron body.

The time of mixing is measured carefully so that each batch is mixed for the same length of time. The various receptacles and the mixer itself are carefully and completely covered so that a minimum of dust escapes.

The mixture is fed to the hydraulic press capable of handling and pressing the hot material at a high rate of speed. The moulds are opened, filled and closed and a pressure of some tons per square inch is applied to the surface of the block. The pressure is then removed and the block ejected and measured. After measurement the block moves forward and is carried under cooling water, and is then ready for use.

Formerly it was essential to import such quantities of Asphalt Blocks as India's needs demanded, from the U.S.A. Now, India can supply her needs from her own shores and that in a form which no outside country can supply either to her or to themselves.

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*There is more than half a mile of Railway Track in the Refinery and Works.
This is the water cooling section for Bitumen Blocks,
Expansion board moulding plant, with storage racks behind.*



Corner of Workshops.

In the United Kingdom these compressed Asphalt Blocks of 9"—12" in length, $4\frac{1}{2}$ "—5" in width and $1\frac{1}{2}$ "—3" in depth, pressed out at about 6,000 lbs. per square inch, have been laid on $\frac{1}{2}$ inch to $\frac{3}{4}$ inch thick of sand and cement screeding in the proportion of 4: 1, on concrete foundations and giving an even bearing for the blocks which are placed in position while the sand and cement are still just plastic.

Such blocks are easily transported from one locality to another without loss or damage. They can further be taken up and inexpensively relaid, while the actual laying is expeditious and the repairs are easy, and, further, the joints and rough surface preclude slippery conditions. Their resistance, imperviousness to water and durability are all factors in their favour as well as their sanitary and dustless propensities. They can also be laid without danger on gradients as steep as 1 in 15, for although durable, their resistance to traffic effort is negligible, while the pressure exerted in their manufacture renders them immune from conditions of climate.

Before we pass from this section in which reference has again been made to vibration and road impact shocks and their remedies, it will be surprising, to some, no doubt, to learn that that a protuberance of one inch in a road surface, struck by a solid rubber tyre travelling at 16 miles per hour would, on impact, be capable of increasing the static load of one rear wheel by as high a multiple as seven.

This will serve to show the ultimate effect of pot-holes, ruts and waves, upon the surfaces adjoining them, apart from the undue vibration and wear and tear transmitted to the vehicles which pass over them.

Let us turn for a moment to the workshops which are charged with the duty not only of maintaining the Works and Refinery but also with the manufacture and supply of those units of plant and machinery which have already been described as requisite for the manufacture of Cold Mix. If ever a sense of permanence and security existed it can certainly be breathed here. Large and small drilling machines, grinders, planing and double slotting machines, circular saws and compressed air-blown forges, are all in evidence. The electrical department

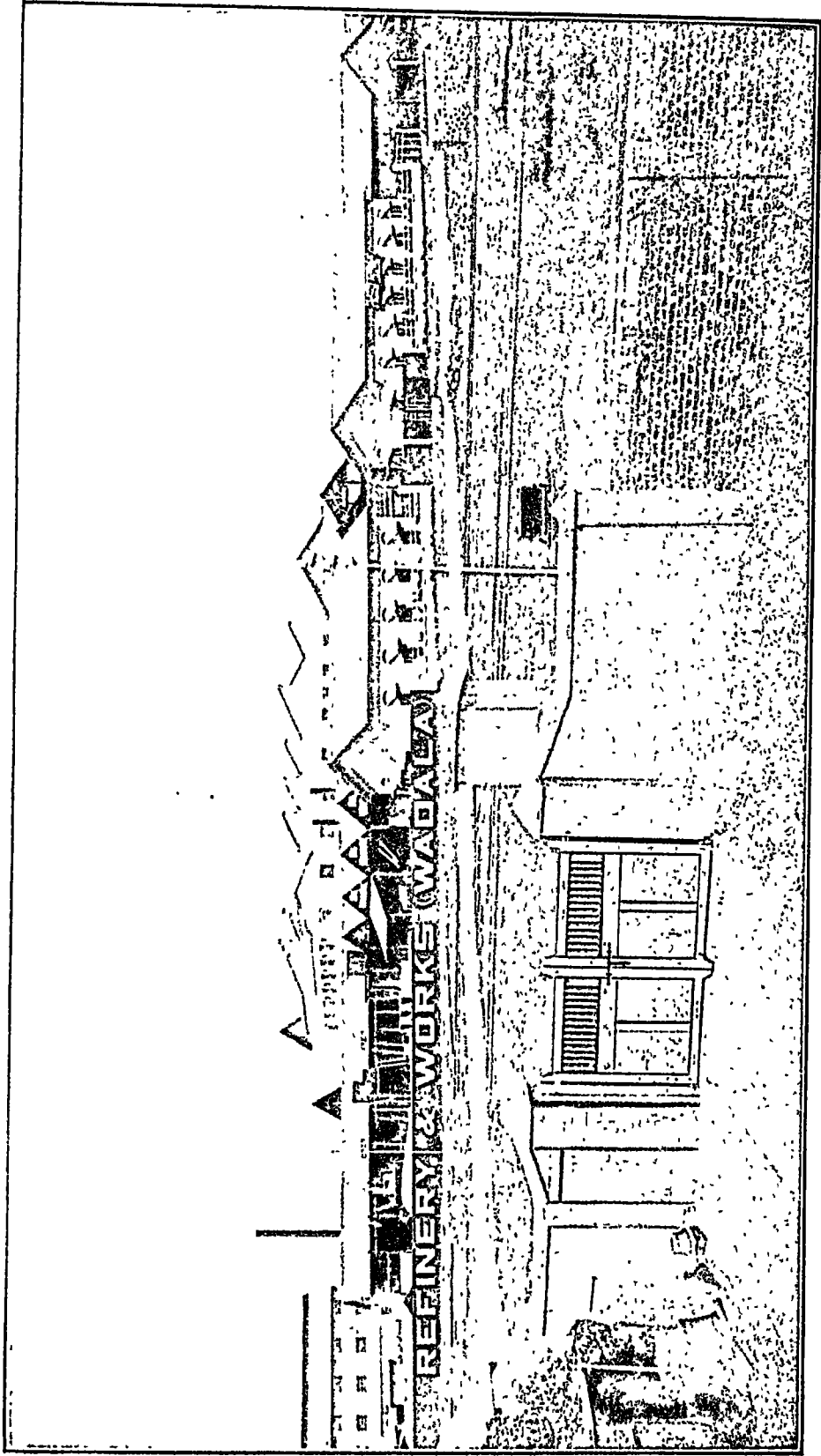
is capable of dealing with any item of the multitude of electrically driven power units of the whole works. Between these two work-shops runs the water cooled railway for treating the Asphalt setts after compression. Nearby is the layout for the manufacture of flexible bituminous expansion boards, to the uses of which other references are made.

We have now completed a somewhat hasty inspection of the Refinery and Works and gained some scanty information regarding the various groups of machinery, their respective functions and the products which are available for the use of the road-makers of the day, through the activities of the machines in association with Iraq Natural Asphalt.

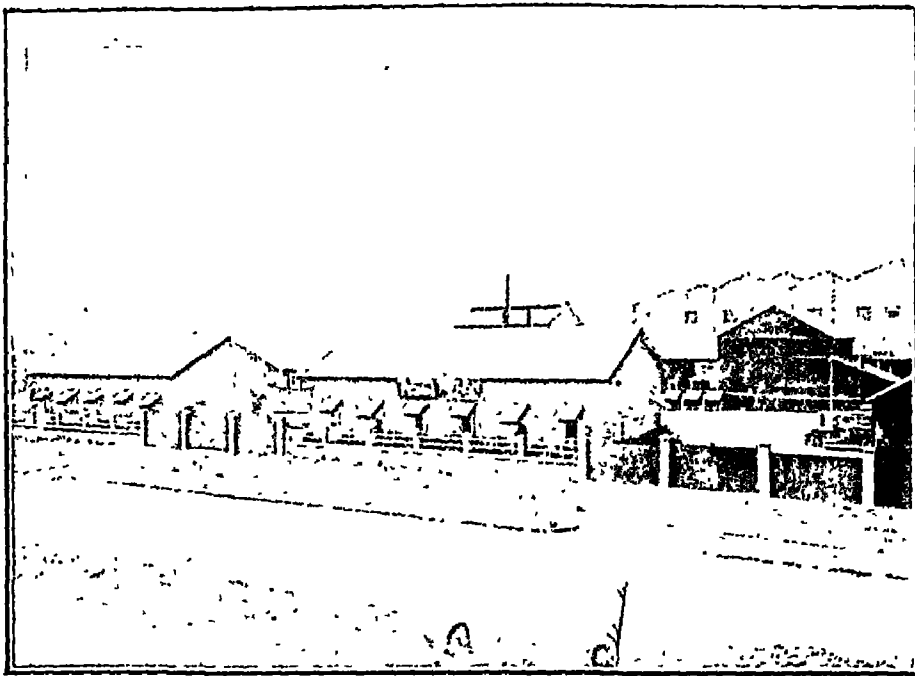
It is hoped that the descriptions given will leave a sense of certainty that no precautionary measures have been left untaken to ensure the good behaviour of Iraq Bitumen—the Binder!

In any case, let us cross over to the House of Correction, as the Laboratory might be called by any of those wicked roads which people so frequently talk about in India.

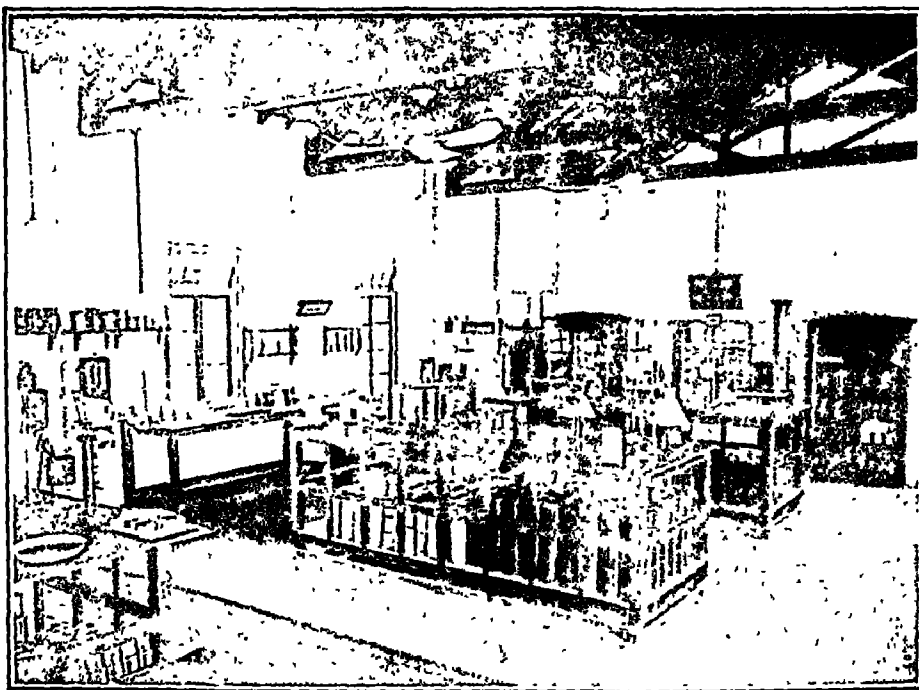
One could almost picture a part of a road which had shown signs of room for improvement, being brought to the Laboratory for enquiry into its behaviour, reading its fate over the door: "Abandon hope," etc.—for they are sure to find out every one of his faults.



*The Mawson - Vernon Company, Limited.
Wadala Installation
View o' Eastern Face showing Administrative Buildings and Research Laboratories.*



Refinery and Works, Wadala. Administrative Offices and Laboratory Buildings



*A view of the Laboratory.
Where all Road Subjects—Good or Bad, receive impartial investigation after
being thoroughly searched.
A veritable chamber of horrors for bad roads.*

CHAPTER IX.

C. I. D.

AND IRAQ BITUMEN

In the Laboratory.

It is not intended by the above title to convey that the Mawson-Vernon Company possesses a police force for the investigation of activities other than those which relate to Roads. The original and ultimate behaviour, however, of the natural products and materials employed by them in the manufacture of the varied commodities for service on the roads in general, as distinct from certain additional articles for commercial use in particular, requires continual inquisition departmentally.

The following instance, however, will suffice, probably, to indicate the degree of investigation which is carried out in the Mawson-Vernon Laboratory at Wadala, by means of scientific research at the hands of those skilled in road analysis.

Reference has already been made to two Babylonian bricks; the one a building stone, the other possibly a pavement slab. Investigations carried through to determine the previous record of the latter, have shown that the proportion of components of aggregate and binder are almost exactly those known to-day to result in the best form of road surface. It will be agreed that this is a subject for amazement. Certainly it is conducive towards a lowly frame of mind to learn that these road makers and builders of old had discovered, probably by a system of elimination, facts and processes which proved the correct compensations in dealing with the affinities of bitumen and river bed mud and silt, and which we to-day, after a lapse of some 2,500 years, with every possible scientific aid and appliance, are pleased to regard as recently acquired original knowledge.

Now so far as the Mawson-Vernon Company is concerned, when laying down their "C.I.D", or laboratory, the Directorate had in view the abolition of that which, in nursery days, would be called in card games, "Old Maid." The object of each player was to attempt to force or induce the others to receive into their hands the "Old Maid," the individual ultimately holding this

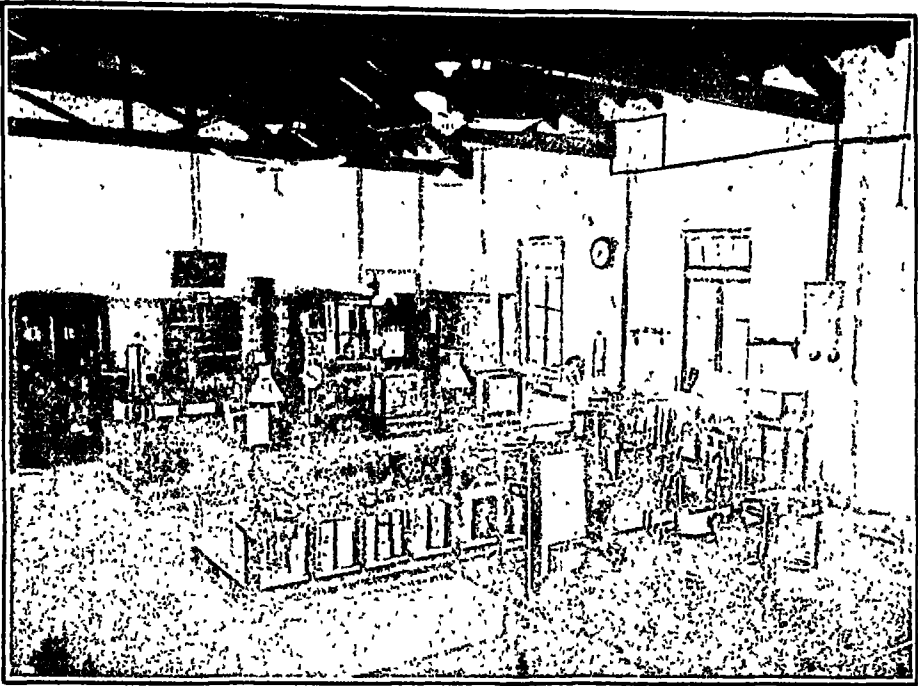
particular card *ipso facto* lost the game. The same system has long been current in the Road World, or Nursery of to-day. The Mawson-Vernon Company will now be in a position to attribute to hard facts, the causes of any failure or obscure eventuality. This will end once and for all, that former practice of forcing the responsibility for failure upon some other party by attributing reasons without providing the requisite tangible evidence to establish definitely : the causes of failure ; who was responsible for those conditions arising which caused the failure, and what reparation shall be made by the offender to the aggrieved party.

No longer will a verdict of "Not Guilty ; the contractor is discharged" be a foregone conclusion, and, obviously, such a position would be distinctly unfair.

To spare just one moment to illustrate this is surely justified, for the usual retort in India regarding complaints, from the point of view of the engineer of a Public Body, has been, when a road surface failed from one cause or another : "Your foundations must have gone wrong," or "You have seepage taking place through 9" of concrete ; it cannot be the Binder: that never goes wrong." Or again, "Well, your sand is quite unsuitable, and how can you expect high caste Binder, such as ours, to mix with your local stone, which really is little better, if at all, than dirt, and, if as you say, our Company told you you could use both sand and stone effectively, well, of course, I'm very sorry, and all that, but I'm only concerned with the Binder, you see, and you really cannot say that it has failed. It is your stone and sand which have failed to unite with our Binder. I do hope you'll be more successful next time." Meanwhile, perhaps, several lakhs of rupees have been more or less wasted, and what is worse, several lakhs more may require to be spent to remedy the failure, apart from the cost of re-instatement as originally designed.

Let us assume for a moment that a 2-inch single coat "Cold Mix" Mawson-Vernon Asphalt surface has been laid in Mattipore.

Twelve months after completion of the last section laid, 6 square yards showed signs of disintegration. The Public Works Engineer at Mattipore sends a few samples down to



A Corner of the Laboratory.



Extracting Benches in the Laboratory.

Wadala, and either indicates the position of the faulty section, or one of the Mawson-Vernon Company's representatives visits the site.

The site is numbered at the date of laying the surface, in the Mawson-Vernon Company's register. From there we come back to the daily record sheet of work done. Meanwhile, the samples from Mattipore have been subjected to all those stringent and exhausting tests which are associated, in other branches of misdemeanour, with the C. I. D., and which leave few secrets hidden.

Evidence extracted from the samples submitted, is forthcoming from the Chief Chemist to the effect that upon analysis it was found that the area which comprised the output of one batch, had failed because of the omission to incorporate in the Mix the full specified quantity of pulverised asphalt. The quantity actually present only amounted to 66% of the correct proportion, and in consequence, the surface coat failed to remain bound after the expiration of twelve months.

It stands to reason, of course, that unless the requisite ratios of the few ingredients are incorporated, any such composition would ultimately fail as would be the case, for example, with concrete if one-third of the necessary quantity of cement was omitted.

Many similar illustrative parallels could be given, attributing the real cause of failure to other combinations or forces, and which, by the dissection, as it were, of the evidence in the Court of the laboratory, cannot fail to be brought to light.

Really, therefore, an analytical Road Chemist to-day needs just as keen powers of detection and equally modern research appliances as the romantic "Dr. Thorndyke."

The Mawson-Vernon Company's Laboratory, its Staff and the facilities they afford, are at the disposal of the Road Engineers of the Public Bodies of India, to aid them in every possible difficulty regarding road construction or failure with which they may come in contact.

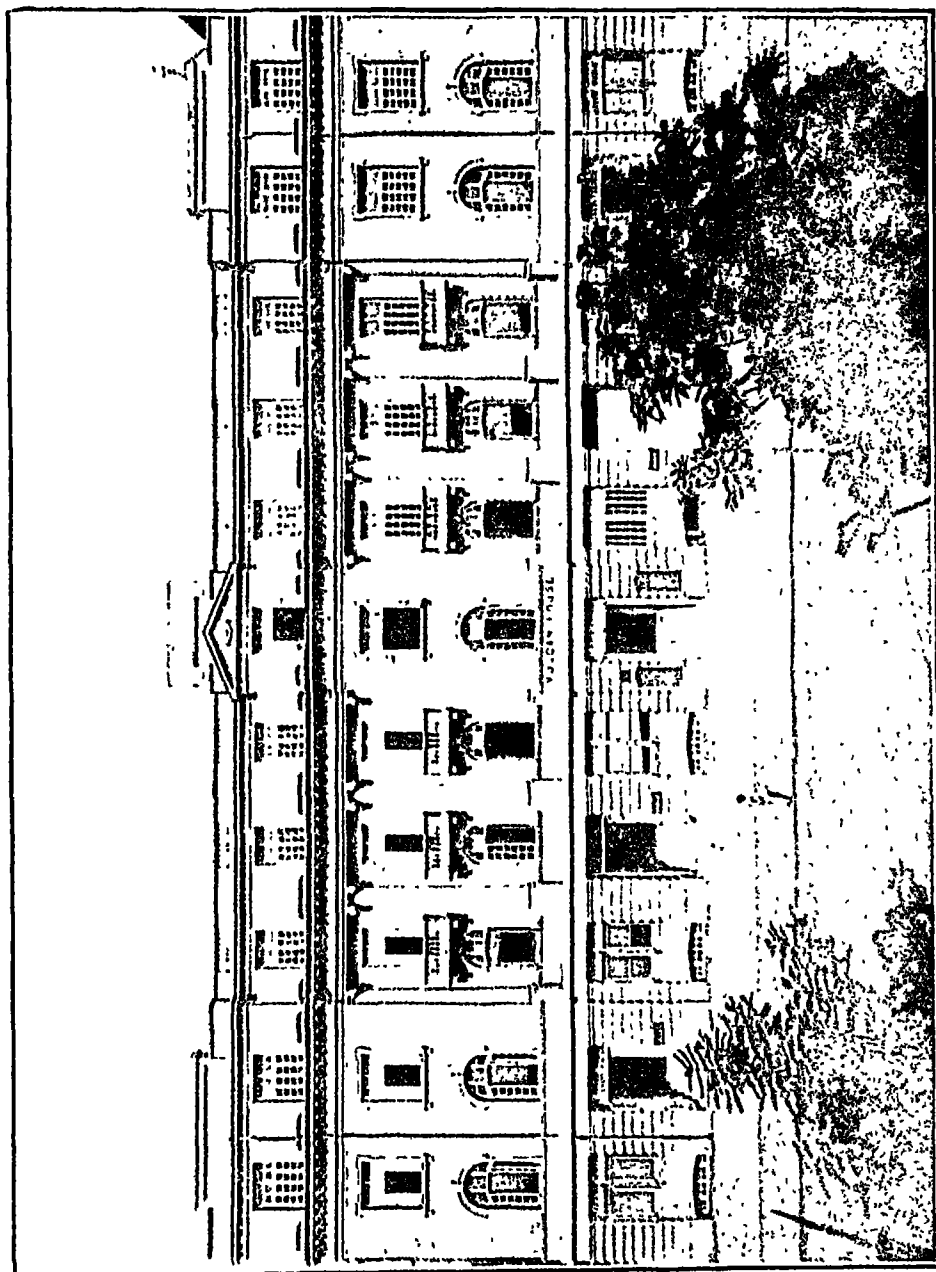
There is one very distinct advantage which the "Criminal Investigation Department" of the Mawson-Vernon Company has over that more widely known Service, which bears a similar appellation, and which also discharges the duty of disinte-

grating, segregating, filtering, screening, washing, weighing, stretching and subjecting to forces of compression, masses of evidence, good and bad, useful and useless, which come under their ken. The advantage is this : criminals may succeed in covering up their traces with such baffling cunning that it is impossible to bring the charge home to any individual. The Mawson-Vernon Company, however, is more fortunate and the laying of false trails cannot be done, for the evidence of the truth, the whole truth and nothing but the truth is extracted in the Laboratory with the aid of microscopes and finally adjusted balances. These will detect minute parts of a grain of evidence which will alter the scales, and that far more rapidly and far more easily than by the force of the "Third Degree."

A lengthy tabulated inventory of the contents of the laboratory, would, very rightly, bore those who are much more concerned and interested in results and protection than they are in the shape or name of a retort, the dimensions of a Penetrometer, or the number of particles of the finest pulverized inorganic filler which, measured by the apparatus in the laboratory, would, if placed end to end, be needed to reach from Bombay to Delhi.

Adequate assurance will doubtless be felt by one and all that the potential ability of this investigation department to enquire into the bad conduct of Roads, must be ample in any case to protect the Mawson-Vernon Company, in view of their enormous stake in India. Obviously therefore, if with road surfaces being laid in all parts of the Peninsula and elsewhere, the laboratory is adequate and capable of coping with the research thus entailed, it must, logically, be more than sufficient to afford its requisite quota of service to any individual City or State.

In the middle ages and even to-day in the city of London, youths, admitted as apprentices by offering their services, are bound by indentures. The Mawson-Vernon Company also offer their services but with a different and much older form of Binder, namely—Iraq Bitumen.



*Vulcan House, Nicol Road, Ballard Estate, Bombay.
Location of the Mawson-Vernon Company, Limited, Central Administration.*

CHAPTER X.

OTHER PEOPLES'

"COLD" ASPHALT ROADS.

Reference has already been made to another form of "Cold" Asphalt which has been successfully laid in the United Kingdom and Europe since the beginning of 1927 and for a considerable number of years previously in Canada and the United States.

At this point therefore, when we have dealt with that portion of the Mawson-Vernon undertaking, viz:— the Works, Laboratory and Refinery, which, by their combined efforts in conjunction with Iraq Bitumen, have rendered it possible, for the first time in Road History, for Cold Natural Asphalt to be manufactured and laid without the introduction of artificially applied heat at any stage,—it is appropriate to allude in detail to the Western process of preparation.

It is probable that a considerable proportion of the road discerning public in India, including those whose calling is wrapped up in the creation and maintaining of roads, would wish to know for purposes of comparison exactly the manner in which the patented "Cold" Asphalt of those countries is manufactured.

Although single coat work is feasible, the system embodies, usually, a base coat, and a surface wearing coat, the latter being regarded, as its designation infers, as a surface which, when occasion demands, can be renewed, whereas the base coat is partly foundational as is the general rule.

The total thickness of material applied is 3 inches which consolidate to 2 inches under the roller.

Particular attention, naturally, is paid to the aggregates and the quality of the stone as regards the crushing strain and behaviour under conditions of wet and dry attrition.

The base coat aggregate consists of crushed material passing a $1\frac{3}{4}$ inch ring, *i.e.*, a $1\frac{1}{8}$ inch stone down to $\frac{5}{8}$ inch inclusive, and the wearing coat is $\frac{5}{8}$ inch to $\frac{1}{8}$ inch, preferably

granulated material. It should be explained that in Great Britain, the system of screening stone generally results in the following gauges being available : $2\frac{1}{4}$, $1\frac{3}{4}$, $1\frac{1}{4}$, $\frac{3}{4}$, $\frac{5}{8}$, $\frac{3}{8}$, $\frac{1}{4}$, and $\frac{1}{8}$ inches.

Another feature which makes itself prominent here is that of stone dust. If, prior to use, exposure to the elements has taken place, a coating of water and dust settles upon the outside of the stone, and is apt to form a dry crust whenever fair weather conditions subsequently obtain. In the event, however, of mixing wet or dirty stone of any other than a hard variety which does not of itself produce dust during its passage through the elevators and drying cylinder, then, encrustation ensues which the very heat intended for drying, serves to bake like cement, as it were, on the face of the stone. The only real safe-guard and remedy in such circumstances is to wash the stone clean, prior to heating, for very serious defects, as will shortly be seen, may result from the fact that this coating of stone dust and water "cement" receives treatment eventually, and which it is imperative should be applied to the surface of the stone if adequate binding qualities are to result.

The stone has first to be dried, involving temperatures in certain cases of 200° — 240° F. whenever material direct from the crusher and consequently dry, is unavailable. In the case of clean stone, however, this is heated to about 140° F. and, after passing through the drying cylinder, is elevated to a storage hopper containing from 10 — 40 tons according to the size of the paddle mixers which are generally 16 cwt. or 36 cwt. batch mixing type. In the hopper, mechanically propelled fans and louvres induce air currents which reduce the temperature stone for mixing to about 90° F.

The reason for this reduction is soon seen, for, after the stone has been admitted to a weighing box immediately above the paddle mixer, it is discharged into the mixer and sprayed with a measured quantity of kerosene of low flash point. The high temperatures of dried stone must be overcome before mixing takes place for, apart from the danger of explosion by igniting the kerosene with a spark emitted by the steel paddles and the stone,—metal, which is too hot, causes the kerosene to evaporate whereas it is required to coat the stone as a key, preparatory to receiving the fluxed bitumen.

It will be appreciated, also, that there is room for variation to take place in the behaviour of each individual batch almost, and that the amount of liquefier to be applied, plus a correct guess as to the temperature of the stone, is hardly a system which could be offered for adoption in India, with Indian labour and conditions as they are.

The bitumen, which is next applied, is residual from a petroleum base with a penetration of above, 45 at 77° F. mixed with a proportion of bitumen fluxed to a penetration of 200 at 77° F.

This mixture is heated in mechanically agitated boilers to a temperature of about 350° F., and is pumped from the boilers through steam jacketed pipes to a cock serving a weighing bucket, and tipped into the revolving mass of kerosene coated stone in the paddle mixers. It speaks well for the machinery that in cold weather the shafting and gears are capable of withstanding this sudden strain put upon it through the contact of cool stone and rapidly hardening bitumen, but apart from occasional belt slips, little damage results. More recently, however, the body of the mixer itself has been steam jacketed.

Having applied some gallons of kerosene to the batch of stone and added a bitumen already containing a flux in itself, it becomes necessary to introduce a lime filler to take up any surplus in volatiles which may be present and to add a stone filler of dry $\frac{1}{8}$ inch to dust. "Cold Asphalt" is then ready for transportation, the mix being varied, of course, according to the distance to be traversed.

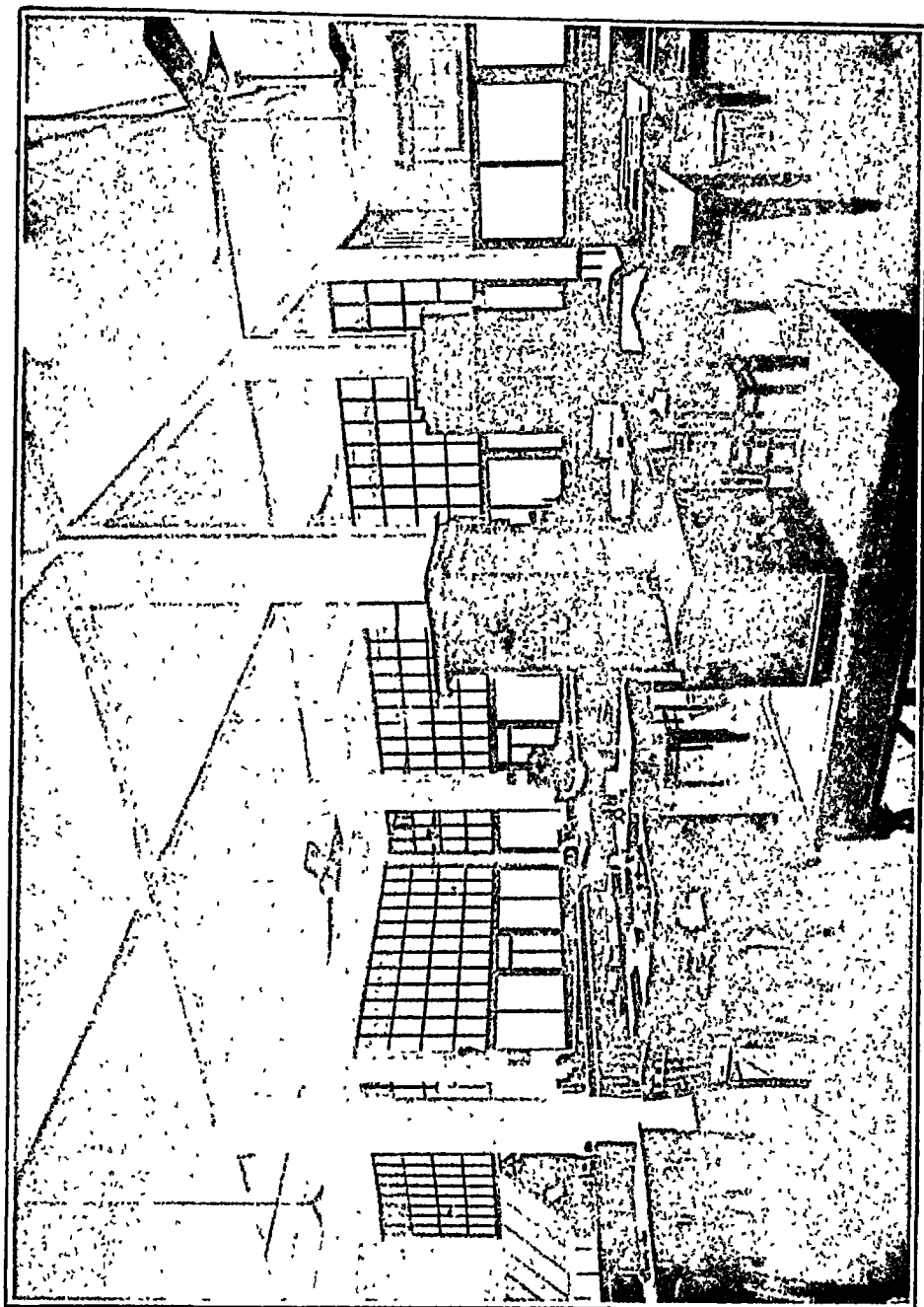
It may with fairness be claimed that this is the best road surface manufactured to-day in Europe, and, apart from one or two disadvantages, which will be mentioned, it is the best nonskid surface known, in Great Britain, where with its intensified motor traffic in and around the Metropolis, this nonskid factor is one of supreme importance.

This description has been given to enable those engaged with the problems of India's roads to compare it with the process of manufacture of India's own "Cold Asphalt" which is "Cold" from start to finish, but this is a minor factor actually, compared with the simplicity of production and the

economy in cost of manufacture of the Mawson-Vernon "Cold-Mix."

The machinery required for a 36 cwt. batch mixing plant, with engine, bitumen boilers and the like, weighing about 19 tons, for that form of Cold Asphalt, costs nearly Rs. 100,000 against the cost of the Mawson-Vernon Plant of some Rs. 7,000.

Sufficient has already been said to enable an opinion to be formed as to the preference for a contractor's simple operation in manufacturing Mawson-Vernon "Cold-Mix," as compared with processes which necessitate that meticulous accuracy ascribed to pharmacists and which, when all that is said and done, is unable to produce a binder which will rank with nature's own binder from Iraq—for without doubt, the strength of any road surface is in the BINDER.



*The Mawson-Vernon Company, Limited.
Part View of General Offices, Vulcan House, Bombay.*

CHAPTER XI.

VARIOUS GUISES OF IRAQ BITUMEN.

There are many allied uses to which Iraq Natural Pulverised Asphalt of this description may be put, for example :

Coal Tar, reinforced in fixed proportions up to 30 per cent. of binder by weight, when required for use with "Tar Macadam," will result in the metal so treated, giving more than twice the life of ordinary tar macadam. By virtue of the high standard of pulverisation, Iraq Asphalt alone is capable of absorption by tar at a temperature of below 200°F.

A binder composed of tar and pulverised asphalt will wear cent. per cent. better and be far more waterproof than plain tar.

The tar is heated up to 170°F. and a definite, weighed quantity of Pulverised Natural Asphalt added and gradually stirred and allowed to dissolve.

Patching and repair works are of a more lasting character, Tar-Asphalt coated metal being covered by a seal mixture of "Tar" Pulverised Asphalt in the usual manner.

Sand, in a Portland Cement Mortar, may be displaced by 20 per cent. of "Pulverised Natural Asphalt" when a damp proof floor is required. The strength of the mortar is scarcely affected, while the damp resisting qualities are greatly enhanced.

Grouting, or hand penetration work, where natural or residual asphalts are used, should always be strengthened by sprinkling Pulverised Asphalt at from 5 to 15 lbs. per square yard immediately over the hot sprayed asphalt surface. This should be done before any sand or grit is applied to the grouted stone. The work should then be finished in the usual method.

The addition of Pulverised asphalt adds "Backbone" to the road, as Asphalt of very high penetration is usually employed on cement work, involving an invariable lack of "body," owing to the reduction in "Asphaltenes". The Mawson-Vernon cold Asphalt is abnormally rich in "Asphaltenes."

To strengthen "Bitumen Emulsions," "Road Oils," and "Cold Asphalts," from 10 to 40 per cent. Pulverised Asphalt can be used with particular advantage.

For cushioning the foundations of heavy machinery, a layer of Pulverised Asphalt, up to 1 inch thickness, may be placed in any break of concrete continuity.

The asphalt will eliminate shock, vibration and foundation rigidity—as a result of which the life of machinery is greatly prolonged.

No. 1 "Road Oils."

THE combination of Flux Oils with natural bitumen in certain ratios, is capable of producing a mixture which, when administered by means of "fish tail" cans to the scarified surface, will render the most dusty roads free from that annoyance to the general public.

Road Oils, as manufactured to-day, are a scientific blending of various bitumens which will, when so required, do more than keep down the dust of a road. The Mawson-Vernon preparations permit of Road Oils acting as "Road Binders," and it is not surprising to hear that with the use of a Road Oil and by special easy methods of application, it is possible to construct a road inexpensively which will last fully two years without requiring re-treatment.

The initial expenditure of Road Oiling is far below the cheapest method of tar grouting while the reduction of the maintenance charges, by treating a road with Asphalt Oils, is considerable. No dust, better health and better roads are some of the advantages brought about by the use of Road Oils.

Road Oils must penetrate, bind and never re-emulsify with water. Here again, the practical test is more instructive than reams of theoretical assertion. Road Oil poured into a glass vessel containing water, proves its inherent qualities to resist any tendency towards re-emulsification. A Water and Bitumen Emulsion, however, will give an optical demonstration of its immediate readiness to do so, as is proved by the claim that it can be used in wet weather.

Any Road surfaces which have been treated for a year or two with Mawson-Vernon Asphalt Road Oil, become, in a natural way, the best of foundations for future asphalt pavements.

The longer the period during which Road Oiling obtains, the less treatment it will absorb and the more it will consolidate.

Any type of road surface, including tar macadam, water bound, earth and gravel may be treated with Road Oils to great advantage.

The older method of spraying Road Oils simply to coat the mere surface, is no longer regarded as efficient or economical to-day.

A depth of some 4 inches should be scarified, the material removed and thoroughly mixed with heavy grade Road Oil and spread back on the sole of the road which has previously received a coating of light grade Road Oil.

The material thus treated is rolled into place by a ten ton three-wheel roller and the surface, after receiving a dressing of our Primer Road Oil, is blinded over with clean sand or gravel for purposes of insulation and for the better preservation of the binder applied.

By this means it is possible to obtain the very best results from an inexpensive method.

It must be borne in mind that by the immediate treatment of a newly cut road with Road Oils, the crust, not the skin only, is being built up to form an excellent wearing service and foundational coat.

No. 2. Mastic Blocks.

These Blocks are prepared from a Natural Bitumen which possesses the essential qualities of waterproofing and stability.

The aggregate consists of the very best ground trap grit, clean sharp sand, and mineral filler of the highest grade.

The proportions are rigidly preserved at the manufactory and the finished product carries from 16 per cent. — 20 per cent. Bitumen, and from 20 per cent. — 24 per cent. Filler. The actual blending of the mixture is carried out at temperatures near 400° F., and the hot Mastic runs into moulds and is cast into blocks.

These blocks are then ready for use and only require to be broken and melted in a cauldron over a fire, when it will be observed that at a temperature of about 320° F. the mixture will flow, and whilst in this condition the contents from the cauldron should be emptied upon the road or floor and run between battens which should be the thickness of the finished surface desired.

The Mastic is levelled by the aid of wooden floats whilst still hot, and polished smooth by wooden smoothers.

Before cooling, the surface should be sprinkled with inorganic Filler.

The high percentage of Bitumen present, ensures a Mixture which will remain plastic and rich for at least 10 — 15 years and quite free from the development of cracks.

Mastic is usually laid from 1 to 2 inch, but it is seldom advisable to use less than 1½ inch thickness.

The finish of a Mastic Floor should be free from joints and very even and pleasing in appearance.

This preparation of Mastic Asphalt is especially intended for works which are subject to inundation with water, such as roofs and terraces, the lining of Canals, Reservoirs and Salt Pans and also for main roads which are prone to be under flood for lengthy periods.

No. 3. *Asphalt Blocks and Tiles.*

The manufacture of Asphalt Blocks as has been already explained, requires a large permanent plant, well equipped and scientifically operated. It must be able to perform the following processes : regulating and handling the asphalt cement, heating and mixing the ingredients, pressing and cooling the blocks, testing and analysing the ingredients and the finished blocks.

The manufacture of Asphalt Blocks was begun in San Francisco in 1869 under great difficulties and with the crudest appliances.

Hand moulds were first used in which the imperfectly prepared mixture was compressed by man power.

Since that time the production of Asphalt Blocks has steadily increased until it has reached a total of over twenty four million square yards, and the present annual production is at the rate of over one million five hundred thousand square yards.

For over 30 years, pavements and floors of Asphalt Blocks have stood the test of heavy service and demonstrated their ability to meet the requirements of varying traffic and climatic conditions. Asphalt Blocks are used extensively for paving City streets and main trunk highways and for the surfacing of piers, bridges, machine shop floors, warehouses and industrial installations.

In certain parts of the United States of America an unbiased observer could draw but one conclusion : the 5 inch concrete pavement, whether reinforced with steel or not, was unable to stand up under the modern truck traffic.

The 8 inch concrete pavement costing upwards of 50,000 dollars a mile was also showing cracks under the pounding.

The test proved beyond the question of a doubt that a permanent highway that will give maximum service, must be built in a manner to absorb the shock of the road traffic.

It is virtually a crime against taxpayers to lay a fine base for a road and then fail to protect the wearing surface by a cushion of Asphalt.

There is another important merit to be claimed for Asphalt Blocks. Because of the resiliency it is easier on traffic than every other type of hard pavement almost, and this is a very important consideration.

Eminent Engineers consider resiliency of prime importance and infinite value in the construction of roads and pavements. The same principle holds good with these as with the shock-absorbing and resilient sand bags and cotton bales of war time, the resilient and shock-absorbing tins, rubber heels, and the golf balls of peace time.

The inability of too rigid, non-resilient pavements to iron themselves out under terrific modern traffic, is the reason for this general belief among Engineers.

No. 4. "*Expansion Joints.*"

The special elastic Expansion Boards and Compositions manufactured at the Mawson-Vernon Works, carry a high percentage of bitumen of pre-determined blending, and a mixture of asbestos and other organic and inorganic materials which are designed to allow the highest degree of elasticity.

The Boards are prepared in lengths up to 12 feet, and in any width or thickness required to suit particular work.

The standard thicknesses are $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, 1 and $1\frac{1}{4}$ inch.

For concrete roads, sett floors and pavements, reservoirs, tramway tracks, bridge construction and in fact wherever it is advisable to calculate and provide for expansion and contraction, it is a highly desirable to employ Mawson-Vernon Expansion Boards.

Unightly cracks are prevented and irreparable loss may be saved by their judicious use.

No. 5. "*Bitumastic Paints.*"

The following paints, japans and black varnishes of unusually effective quality, are manufactured and prepared for particular works :—

Masonry Paints :

- (a) For painting outside of walls.
- (b) For painting inside of walls of buildings and cellars.

Timber and Wood Paints :

Specially prepared to preserve timber and contain no resin whatever.

Steel Paints :

- (a) For Machinery.
- (b) For Agricultural Tools and Implements.
- (c) For Railroad Bridge Girders.
- (d) For Steel and Cast Iron Pipes buried or above ground.
- (e) For Corrugated Iron Roofs.
- (f) For Cast Iron and Steel Structures.
- (g) For Telephone and Telegraph Columns.

Black Japans :

For quick drying and tough coating pipes, etc.

Insulating Paints and Varnish :

For electrical machinery, coils, armatures, switches, wires, etc.

These paints are prepared from a natural high fusing refined asphalt. They contain no adulteration, fillers, etc., and are guaranteed for the work for which they are intended.

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